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SUPPLEMENTARY EDUCATIONAL MONOGRAPHS
Published in conjunction with
THE SCHOOL REVIEW *and* THE ELEMENTARY SCHOOL JOURNAL

No. 17 December 1920

AN EXPERIMENTAL STUDY OF THE EYE-VOICE SPAN IN READING

By
GUY THOMAS BUSWELL

THE UNIVERSITY OF CHICAGO
CHICAGO, ILLINOIS

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CHAPTER I

INTRODUCTION

PROBLEM

In oral reading the eye always moves at a greater or less distance in advance of the voice. For a mature reader the eye leads the voice by a wide span, which at times amounts to as much as seven or eight words. The immature reader, however, such as a pupil in the primary grades, has a very narrow span. For such a reader the eye does not move from a word until the voice has spoken it, and reading in many cases consists merely of a series of spoken words. The eye-voice span, in that case, is reduced to a minimum. A simple experiment of placing a card over a printed page and uncovering only a word at a time will demonstrate the situation which would exist if the eye and voice were kept very close together. Interpretation of the passage is difficult under such conditions. An eye-voice span of considerable width is therefore necessary in order that the reader may have an intelligent grasp of the material read, and that he may read it with good expression. If words are encountered which are spelled alike but pronounced differently such as "read" (present tense) and "read" (past tense), the correct pronunciation and meaning cannot be determined in many cases until the eye has observed the context by looking ahead. A still further need for a wide eye-voice span is apparent when marks of punctuation are encountered. This need is well illustrated by the reading of children when they arrive at a question mark without having seen it in advance and find their vocal expression entirely unprepared for it. Their failure to respond with a rising inflection of the voice is clear evidence that they were not looking ahead and that they were not getting the thought in large units. The eye-voice span is of real significance, therefore, in the reading process. In the diagnosis of difficulties in reading a measure of the eye-voice span often affords a definite basis for treatment. Treatment not uncommonly involves the construction of definite methods of teaching which will serve to increase the width of the span. The purpose of this study is to determine more fully and accurately the nature of the eye-voice span.

The problem will be considered in three divisions. In the first (*a*) a study will be made of the differences in the width of the eye-voice span in the different grades and in the high school, and (*b*) the variation in the width of the span in different parts of the sentence. In both (*a*) and (*b*) the results will be presented in such a way as to show separately the characteristics of pupils with mature and immature reading habits. Following this, (*c*) a comparison will be made to show the relationship of the width of the eye-voice span to rate of reading, number of fixations per line, and regressive movements.

In the second division (*a*) a very detailed analysis of eye-voice relationship will be made, which will show the exact position of the eye and voice at each eye-fixation and will exhibit the variations in the width of the eye-voice span in the reading of different passages by a single individual. These results will be used (*b*) in an effort to explain the cause of the occasional very long eye-fixations which appear in reading records.

The third division of the investigation will make use of a test device, consisting of a paragraph containing several words spelled alike but pronounced differently, by which the eye-voice span in oral reading will be studied in relation to the recognition of meaning in silent reading.

PREVIOUS STUDIES

Previous to this time the subject of this investigation has appeared, so far as the writer can discover, only twice in the literature of experimental studies of reading. In 1897 Quantz[1] did some work on the problem without the use of elaborate apparatus. His experiment was carried out by quickly slipping a card over the page while the subject was reading and recording the number of words spoken after the view was cut off. The method gave results which, for two reasons, are not directly comparable with those of the present study. The first is that the method did not record the location of the eye's fixation at the instant the view was cut off, but recorded the number of words which could be correctly given. In ordinary reading material more words could be given than were actually seen, by simply filling out the content of the meaning. This would cause a considerable error in the results which might have been partly reduced by the use of non-sense material instead of the meaningful material used. The use of such material would, however, have introduced another difficulty due to the fact that non-sense material is not normal reading-matter. The method used by Quantz gave an apparently wider eye-voice span than actually existed. The second factor which would cause a difference in results from those of the present study is that by Quantz's method the number of words recorded would include all which were seen even to the limits of the perceptual area, while by the method of this investigation the location of the eye is recorded at a point within the fixation area. This again operates to give a wider span for Quantz's study.

---

[1] J. O. Quantz, "Problems in the Psychology of Reading," *Psychological Review Monograph Supplement*, Vol. II, No. 1. 1897. Pp. 1–51. Princeton, N.J.: Psychological Review Co.

Quantz computed the correlations between eye-voice span and rate of reading and between eye-voice span and the positions in the line. He found a high correlation between reading rate and the width of the eye-voice span. He also found that the span depended to a great extent upon the point in the line at which the view was cut off. He reports an average span of 7.4 words at the beginning of a line, 5.1 words in the middle, and 3.8 words at the end of the line.

The second reference which has been made to this problem is found in the study made by C. T. Gray[1] in 1917. Gray's report gave seven plates showing the readings of six subjects, one from the seventh grade, two from the high school, and three from college students. No detailed analysis of the records was made and no correlations were given, but his conclusions were summed up in the statement that "the separation between eye and voice in oral reading varies from individual to individual or from point to point within the same selection."

With the exception of these two brief references, no previous investigations appear in the literature canvassed by the writer.

APPARATUS AND METHOD OF PRESENT STUDY

The apparatus and general method of this investigation are the same as used by C. T. Gray and other investigators in the Chicago laboratory. They are fully described in Gray's[2] monograph. One change was made in the equipment there described. The hand-feed arc lamp was discarded and a new three-wire automatic arc was installed in its place. This lamp is automatically fed by a magnetic release and has the advantage of producing a beam of light of constant intensity and at a constant point of location.

Without describing the apparatus in detail, it may be well to describe in general the method of this investigation. It consists of photographing a beam of light, generated by the arc lamp, reflected first to the cornea of the eye from silvered glass mirrors, and then from the cornea through a camera lens to a moving film. The pencil of light changes its direction with each movement of the eye. The subject reads and a photograph is made on the film which records the movements of the eye as a sharply focused line. An electrically driven tuning-fork, with a vibration rate of fifty times per second, is mounted in the path of the beam of light in such a way that the light is intercepted at each vibration. These vibrations produce on the film a line of dots rather than a solid line, each dot representing a time of exactly one-fiftieth of a second. Since the film is moved continuously in the vertical plane, the record shows a vertical line of dots while the eye is fixated in a single position, and a short horizontal line when the eye is in motion in a horizontal or oblique direction. Vertical movements of the eye are lost. A second line, the head-line, is obtained on the film by the reflection of the light from a bright nickel-plated bead fastened to the rim of a pair of spectacles worn by the reader. This line shows any head movement which may occur, and since it is impossible to eliminate all head movement, this line is of the greatest importance. Every eye-fixation is located with reference to the position of the head-line, and by this means correction is made for all head movement. This brief statement of apparatus and method may be supplemented by the very detailed explanation given in Gray's monograph.[1]

---

[1] C. T. Gray, "Types of Reading Ability as Exhibited through Tests and Laboratory Experiments," *Supplementary Educational Monographs*, Vol. I, No. 5. Chicago: University of Chicago Press, 1917. Pp. 106–20.

[2] *Ibid.*, pp. 83–90.

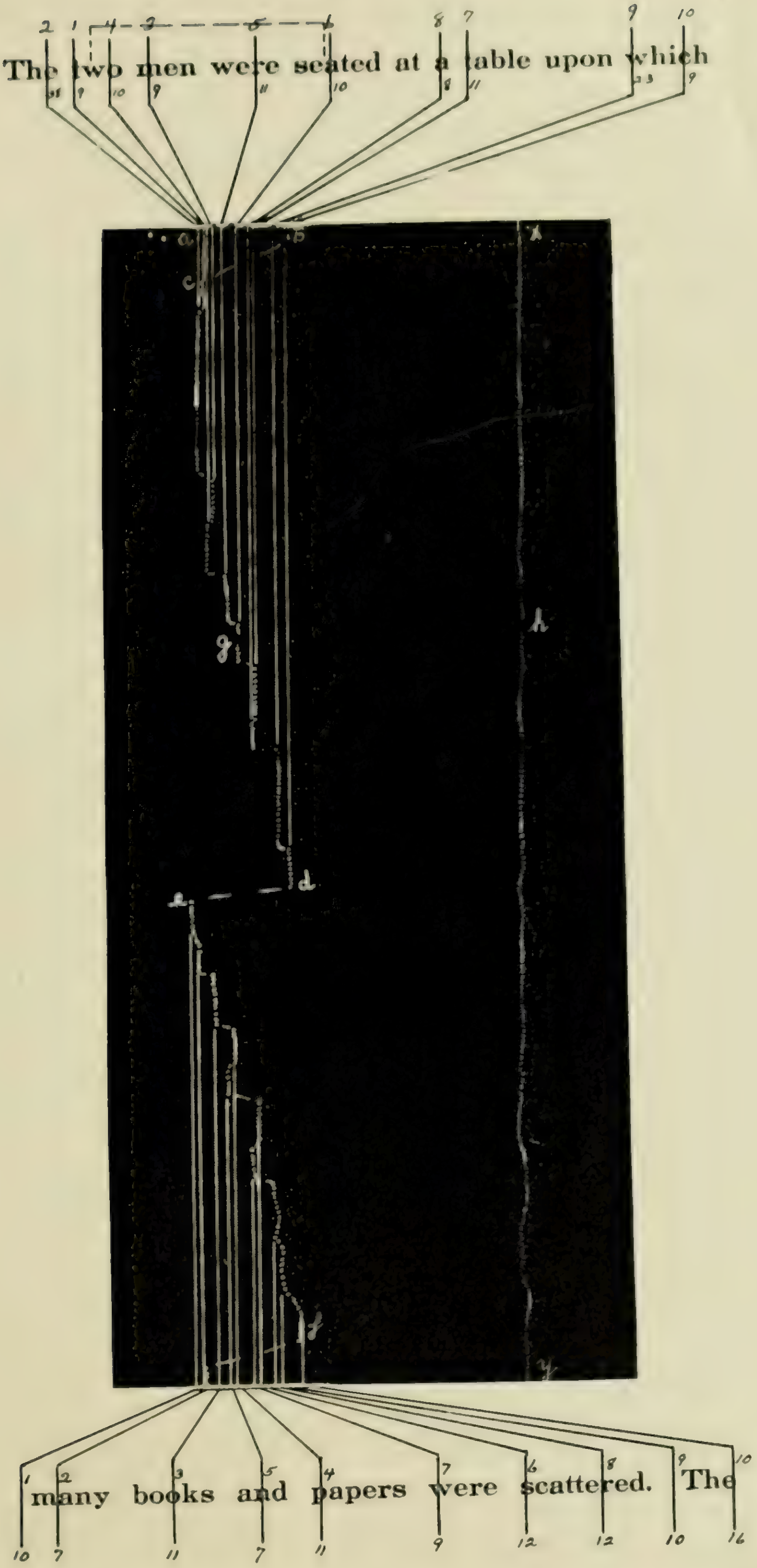
The method of determining the location of the fixations on the printed lines from the film record has not been adequately described in previous studies. This part of the technique is of sufficient importance to receive a careful explanation here. Plate I shows the film record for the first two lines read by Subject H5. On this plate, line *xy* is the head-line made by the reflection from the metal bead. The upper part of the line shows little head movement, but the lower part shows such movement very distinctly. Movements of the head such as occur at the lower part of the plate would cause an error in locating fixations of as much as four or five letters, if the head-line were not provided for correction. Many head movements, especially for children in the lower grades, are much greater than those shown by this subject.

The eye record made by the light reflected from the cornea is shown in the lines *cd* and *ef*. The line *cd* represents the reading of the first line of the paragraph, and the line *ef* the reading of the second. The vertical lines of dots show the fixations of the eye. The horizontal line *de* shows the movement of the eye from the end of the first line to the beginning of the second. Since each dot on the film represents one fiftieth of a second, this movement from line to line consumed two fiftieths of a second. By counting the dots it will be found that the last fixation of the first line took nine fiftieths of a second, and the one just before it, twenty-three fiftieths.

---

[1] C. T. Gray, *op. cit.*, pp. 86–90; 106–20.

PLATE I


The two men were seated at a table upon which
a
b
c
g
h
d
e
f
x
y
many books and papers were scattered. The

Location of fixations from film record on lines of print, Subject H5

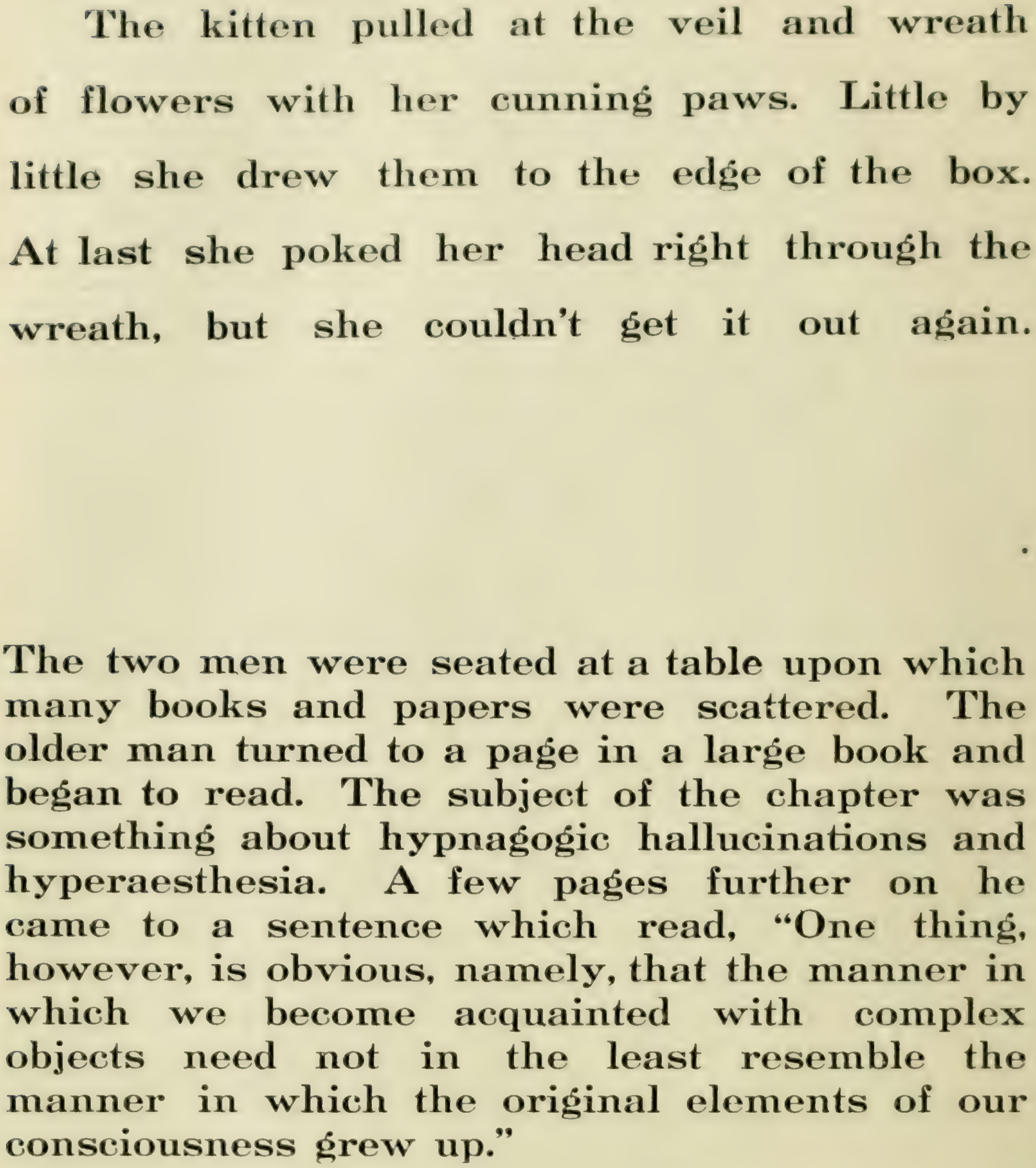
The points *a* and *b* on the plate are related to the printed matter read by having the reader fixate his eyes upon a dot placed just above the first letter of the first line, and then upon another dot just above the last letter of the line. The fixation for the first dot cannot be shown on this small section of the film, but the point *a* lies in the vertical extension of that fixation. The point *b* lies in the path of the fixation on the second dot, a few dots of the fixation showing just below *b*. The distance, therefore, from point *a* to point *b* equals the distance covered by a movement of the eyes from one end of a line of print to the other, and all fixation movements will fall on the film between lines extended vertically from these points. If the film were further enlarged until point *a* rests over the first letter of the first line and point *b* over the last letter, the vertical projections of the fixations would fall exactly over the letter upon which the eye was fixated at that time. For the first line shown in the plate, the first fixation would fall exactly over the first letter of the word "two"; the second fixation would fall exactly over the last letter of "the"; the third fixation would fall exactly over the first letter of "men"; etc. It was by this method that all of the films were translated into positions of the eye on the printed lines. The film was run through a stereoptican projection apparatus which enlarged the record on a screen until the points represented on the plate by *a* and *b* exactly coincided with the edges of the paragraph. The film was then wound through the stereopticon on a spool, and the location of each fixation marked on the letter over which it passed. The length of the fixation was recorded at the same time by counting the dots on the film. In Plate I, the fixations are connected by vertical extensions to the line connecting points *a* and *b*. The lines drawn from these projections to the words intersect the words at exactly the place where the fixations would be located if the film were enlarged until line *ab* was equal to the width of the printed line.

In order to get a record of the voice the photograph was supplemented by a dictaphone record of the oral reading taken for all subjects at the same time the photograph was made. The speaking tube of the dictaphone was placed directly in front of the reader's mouth. In order to record the exact relation to the eye-movements on the film, the speaking tube was divided, one section being attached to a box containing a tap-bell operated by an electric switch. This same switch also operates a camera shutter with its action reversed so that it is normally open instead of closed. The shutter is placed in the path of the beam of light in such a manner that when the switch is operated quickly the beam of light is shut off for an instant and the bell rings at the same time. The breaks in the photograph and the bell signal on the dictaphone record thus make it possible to synchronize the operations of the eye and voice. A typical interception on the film is shown in a short gap in the film line in Plate I, at point *g* on the eye-line and *h* on the head-line. The bell records a sharp click on the dictaphone wax record at the same time. In Plate I the break in the eye-line occurred during the sixth fixation at point *g*. This point on the printed copy falls on the third letter of the word "seated." The dictaphone recorded the click of the bell at the same time that the subject was pronouncing the word "two." This means that when the subject was pronouncing "two" his eye was fixated upon the word "seated." The interval from "two" to "seated," as marked on the plate by a dotted line, shows the distance that the eye was ahead of the voice. This is the interval spoken of as the eye-voice span. The eye-voice span could be determined at any desired place in the reading by simply pushing the switch key at the time the subject pronounced that particular word. This was done nine times in the reading of each elementary pupil, and eight times during the reading of each high-school pupil. The wax record gave a means of checking the movement to see if it occurred at exactly the place desired. If it should occur too soon or too late the dictaphone furnishes a means of correction.

SUBJECTS EXAMINED IN THE PRESENT STUDY

Photographs were taken of the readings of fifty-four different subjects selected as follows. Two good and two poor readers were selected from each of the elementary grades above the first, on the basis of scores made in William S. Gray's Oral Reading Paragraphs. Three good and three poor readers were selected through the co-operation of the English department and the high-school principal from each of the four high-school classes. Six adult college students were selected at random and ranked into two divisions, one better than the other. The three poorer adult subjects were, however, fairly good readers. The entire group of subjects, therefore, included twenty-four from the elementary school, twenty-four from the high school, and six college students, each grouping being made up of equal numbers of good and poor readers. Great care was used in the selection of these groups in order that all the characteristics of the subjects might be known in advance so as to clear the way for concentration of attention during the investigation on the one matter of the eye-voice span. The reading rate of all subjects was taken at the time of the experiment, using material of the same degree of difficulty as that used for the photograph.

PLATE II



The kitten pulled at the veil and wreath of flowers with her cunning paws. Little by little she drew them to the edge of the box. At last she poked her head right through the wreath, but she couldn't get it out again.

The two men were seated at a table upon which many books and papers were scattered. The older man turned to a page in a large book and began to read. The subject of the chapter was something about hypnagogic hallucinations and hyperaesthesia. A few pages further on he came to a sentence which read, "One thing, however, is obvious, namely, that the manner in which we become acquainted with complex objects need not in the least resemble the manner in which the original elements of our consciousness grew up."

Selections used for the experiments

CHAPTER II

THE EYE-VOICE SPAN

DETAILED STATEMENT OF METHOD

Units of measure.—Throughout the study the unit of time measure is one-fiftieth of a second, corresponding to the vibration rate of the tuning-fork time-marker. In all of the plates shown the length of fixations is given by the row of figures beneath the printed line, and is recorded in units of fiftieths of a second.

The unit of measure for the width of the eye-voice span is one letter-space. The term "letter-space" may be defined as the space taken by one letter or one punctuation mark, or the blank space between words. This unit is an arbitrary one, but is constant throughout the study. For the selections used the average number of letter-spaces per word is five. Therefore the denomination of any of the results may be transposed from letter-space units to word units by dividing by five.

Reading selections used.—The reading selections used for this part of the study are reproduced in Plate II in the same form and size of type as used in the experiment. The upper selection, taken from one of the Courtis silent-reading tests,[1] was read by the pupils selected from the elementary grades. This paragraph was chosen because it was desirable to use a selection which was not too difficult for second-grade children, but could be used also for the pupils of the five higher grades. The paragraph was found to be well adapted to this purpose. The selection used for the elementary pupils was necessarily shorter than that used for high-school students, since the younger children read more slowly and the time for taking the photograph was limited by the length of the film. The films used were forty-two inches long, and in passing through the camera allowed fifty seconds of reading time. The elementary pupils were directed to "read naturally just as you would if you were reading in class for your teacher." From all objective evidence the pupils did read naturally and were not disturbed by the apparatus. The subjects from the second grade carried out the experiment fully as well as those from the higher classes. When the subjects began to read they apparently forgot about the apparatus and centered all their attention upon the reading.

---

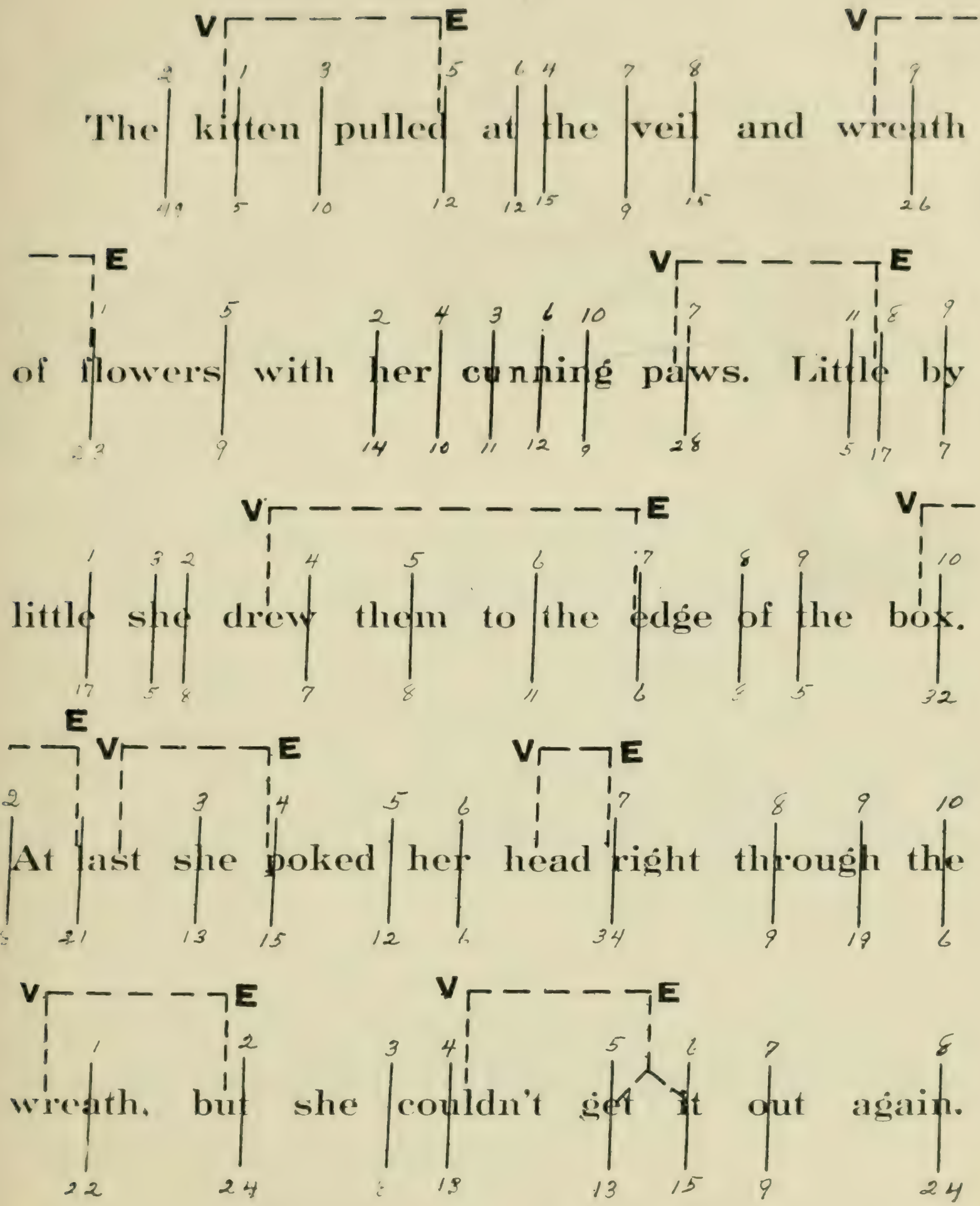
[1] S. A. Courtis, "The Kitten Who Played May-Queen," Silent-Reading Test No. II, Form I. *Standard Research Tests.* Detroit: S. A. Courtis.

The selection shown in the lower part of Plate II was used for the high-school and college students. It was constructed with three purposes in mind. The first aim was to provide a few lines of easy, normal reading-matter. The first four lines provide this. The second purpose was to introduce a few new and difficult words to find the reaction to that kind of a situation. The three words in lines five and six were therefore introduced, and were found to be new to all of the high-school subjects. The third aim was to introduce a sentence made up of easy words but containing a difficult thought. The last sentence in the paragraph taken from James' *Principles of Psychology*, satisfied this requirement. The subjects were directed to "read the paragraph naturally, just as you would a newspaper. If you meet any new or difficult words, pronounce them the best you can and go on. Try to remember the thought well enough so you could tell what you have read if asked to do so." The introduction of the three difficult words in lines five and six caused such a disturbance of the eye-movements that the results for these two lines are entirely omitted in the table of general data and in all general averages given throughout the study. The difficulties encountered will, however, be given special treatment in the next chapter.

Explanation of typical records.—In order that the discussion in this report may be more easily followed, a detailed explanation of the plates of two typical subjects will be given here. Plate III shows such a record from a pupil belonging to the elementary school and Plate IV, one from a student in the high school.

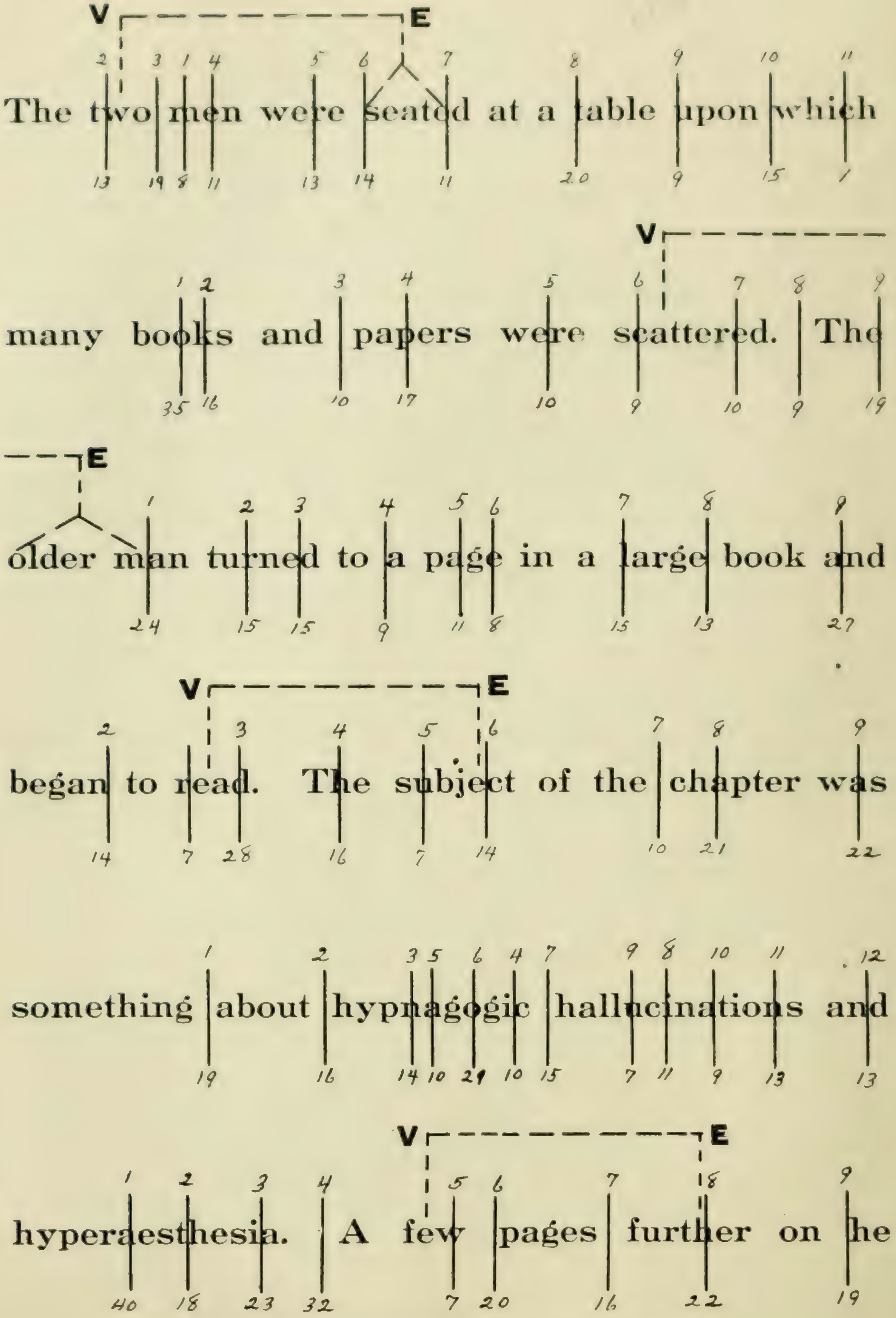
Plate III shows the oral reading of a poor reader from the fourth grade. The short vertical lines drawn through the words indicate the points of eye fixations. The serial numbers above the vertical lines indicate the order of the fixations, while the numbers at the lower end of the lines indicate the lengths of the fixations in fiftieths of a second. Referring to the first line of this plate it will be seen that the first fixation fell upon the word "kitten" and that the eye remained there for five fiftieths of a second. The subject evidently did not feel sure of the beginning of the line, as indicated by the position of the second fixation which fell just after the first word of the line. The eye remained fixed at this point for forty-nine fiftieths of a second. The third fixation was located just before the third word and lasted for ten fiftieths of a second. The succeeding fixations may be observed by following the upper series

PLATE III


The kitten pulled at the veil and wreath
of flowers with her cunning paws. Little by
little she drew them to the edge of the box.
At last she poked her head right through the
wreath, but she couldn't get it out again.
V
E

Eye-voice span of Subject E12, poor reader, Grade IV

PLATE IV



The two men were seated at a table upon which many books and papers were scattered. The older man turned to a page in a large book and began to read. The subject of the chapter was something about hypnagogic hallucinations and hyperaesthesia. A few pages further on he

Eye-voice span of Subject H2, good reader, freshman

PLATE IV*a*

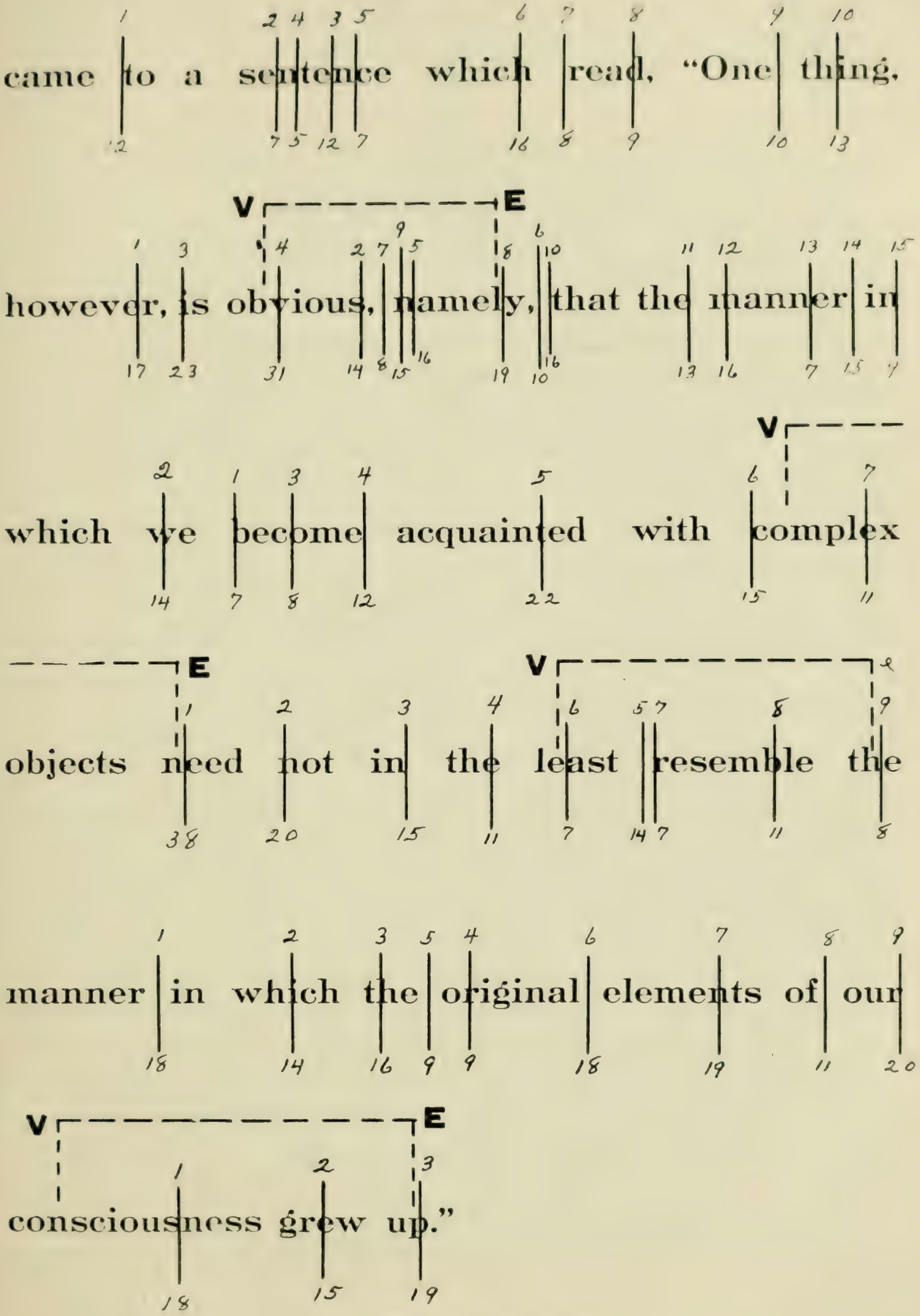


Plate IV—*Continued*

of numbers in order. The function of this investigation is concerned with the eye-voice span rather than with the nature of these fixation pauses. A very thorough analysis and interpretation of eye-movements and fixations in reading have been made in another monograph of this series.[1]

The eye-voice separation is shown, for several typical positions, in Plate III by a bracket of broken lines. The position of the voice is marked by the letter *V* and the position of the eye, by the letter *E*. Referring to the first line of this plate, it will be seen that when the voice was pronouncing the word "kitten" the eye was fixated on the last letter of the third word. If the number of letter-spaces included in the bracket connecting the positions of the voice and eye are counted, it will be found that the eye-voice span at this position is 11 letter-spaces. The eye-voice span was next measured at the end of the first line. As the voice was pronouncing the first part of the word "wreath," the eye was fixated on the first letter of the word "flowers" in the next line, making an eye-voice span of 8 letter-spaces plus the time consumed in moving back to the beginning of the line. Likewise, when the voice was pronouncing "paws" the eye was fixated on the last letter of "little," making a span of 9 letter-spaces. In the last line of Plate III the voice was pronouncing the word "couldn't" just as the eye was moving from the fifth to the sixth fixation. This occurred frequently, and in such cases the span was measured from the position of the voice to a point half-way between the two eye fixations, as shown by the branching of one arm of the bracket in this case.

As explained in the preceding chapter, the operation by which the positions of the eye and voice were determined was controlled by an electric switch. It was therefore possible to measure with exactness the eye-voice span at any desired position in the paragraph by simply pressing the connection at that point in the reading. For the sake of comparisons, nine positions were selected in the passage read by elementary pupils. These positions are shown in Plate III by the letter *V*, at the beginning of the brackets, which occurs just above the word which was being spoken at the time the measure was taken. These positions, in order through the elementary selection, occurred at the words "kitten" and "wreath" in line 1, "paws" in line 2, "drew" and "box" in line 3, "last" and "head" in line 4, and "wreath" and

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[1] C. H. Judd and others, "Reading: Its Nature and Development," *Supplementary Educational Monographs*, Vol. II, No. 4. Chicago: University of Chicago Press, 1918.

"couldn't" in line 5. In general, the measure was taken at the time the voice was pronouncing the first part of the word. Any variations from this were checked and corrected by means of the dictaphone record. Two of these positions occur at the beginning of a sentence, five within a sentence, and two at the end of a sentence. Also, three occur at the beginning of a line, four near the middle of a line, and two at the end of a line. The location of the positions of measurement in this way makes possible not only an analysis of the eye-voice span by positions, but also makes a uniform distribution from which the average span can be regarded as representative of the paragraph as a whole.

Plate IV gives a typical reading by a high-school pupil. The plate shows the oral reading of Subject H2, a good reader from the freshman class. The method of indicating fixation and eye-voice span is the same as just described for Plate III. In this paragraph eight positions were selected for measuring the eye-voice span. These positions, in order through the paragraph, occurred at the word "two" in line 1, "scattered" in line 2, "read" in line 4, "few" in line 6, "obvious" in line 8, "complex" in line 9, "least" in line 10, and "consciousness" in line 12. Two positions occurred at the beginning of a sentence, three within a sentence, and three at or near the end of a sentence. The positions are also distributed according to position in the line.

A question may arise here whether an average eye-voice span, computed from eight or nine positions in a paragraph, is an adequate measure of the general character of the span for every word in the whole paragraph. In chapter iii of this report, a complete analysis showing the eye-voice span at every word and every fixation in the selection will be given, and a comparison will be made with the results obtained from the eight and nine position measures. The comparison shows a small variation in the average span obtained by the two methods.

Table of general data.—In Table I the general data for all subjects are shown. The elementary subjects' numbers are given the prefix E, the high-school subjects H, and the adult college students A. The table gives the subject number, school grade, quality of reading, average eye-voice span, average variation from the average, average number of fixations per line, average number of regressive movements per line, and rate of reading in number of words read per second. This table is intended only for general reference, summaries being given in later tables. It is analyzed in detail throughout the remainder of this chapter.

TABLE I

General Data for Oral Reading—All Subjects*

Subject	Grade	Quality	Average Eye-Voice Span	Average Variation	Average Number Fixations per Line	Average Number Regressive Movements per Line	Rate of Words per Second
E1	II	G	11.8	2.5	10.8	3.0	2.5
E2	II	G	10.3	3.9	9.0	1.8	2.5
E3	II	P	3.4	1.1	18.6	5.8	0.3
E4	II	P	7.4	4.1	12.0	3.4	1.0
E5	III	G	12.7	2.8	9.4	1.1	2.2
E6	III	G	13.7	2.6	9.0	3.1	3.6
E7	III	P	8.0	2.8	19.7	5.5	2.1
E8	III	P	12.6	3.6	14.0	2.6	2.3
E9	IV	G	11.1	5.0	7.8	1.0	3.3
E10	IV	G	16.6	7.5	7.5	1.2	4.0
E11	IV	P	4.0	1.4	11.2	1.2	1.3
E12	IV	P	8.2	2.3	9.4	1.4	3.4
E13	V	G	19.7	3.3	6.8	1.6	3.7
E14	V	G	13.9	5.0	9.6	1.4	2.5
E15	V	P	12.4	4.8	9.2	1.2	2.8
E16	V	P	7.0	2.6	11.8	3.2	3.4
E17	VI	G	14.9	4.1	8.4	2.0	3.7
E18	VI	G	8.9	4.4	7.0	1.4	4.0
E19	VI	P	8.0	1.5	9.4	2.0	3.2
E20	VI	P	14.4	2.5	7.0	1.2	2.0
E21	VII	G	12.0	4.3	8.2	0.8	4.2
E22	VII	G	19.7	3.4	7.6	1.0	3.5
E23	VII	P	11.4	4.2	8.4	1.8	3.1
E24	VII	P	7.3	2.3	12.2	3.0	2.9
H1	F	G	19.8	4.6	7.7	2.1	3.9
H2	F	G	14.2	1.5	9.6	1.0	3.3
H3	F	G	13.3	1.1	7.9	1.4	4.4
H4	F	P	10.0	0.7	10.0	2.2	2.9
H5	F	P	12.0	2.0	10.5	1.9	3.6
H6	F	P	12.4	3.5	11.9	2.4	3.4
H7	So	G	12.0	5.2	8.3	1.5	3.9
H8	So	G	15.5	5.0	8.1	1.6	3.5
H9	So	G	16.0	4.7	7.2	0.2	3.9
H10	So	P	14.1	3.3	8.3	1.5	4.4
H11	So	P	9.6	2.5	9.2	1.4	3.6
H12	So	P	13.8	2.0	8.3	1.3	3.9
H13	J	G	13.8	2.9	6.4	0.4	4.6
H14	J	G	17.7	4.2	8.1	1.6	4.2
H15	J	G	12.3	1.9	10.9	2.3	3.2
H16	J	P	8.5	2.4	9.8	1.2	4.5
H17	J	P	4.7	2.0	9.3	2.0	3.3
H18	J	P	11.5	0.5	10.7	0.9	3.7
H19	Se	G	12.8	3.5	7.4	0.2	4.3
H20	Se	G	23.0	7.0	9.9	1.3	4.8
H21	Se	G	12.0	3.3	9.9	0.7	3.4
H22	Se	P	13.9	3.6	10.7	3.2	3.7
H23	Se	P	10.8	1.3	10.7	1.2	3.4
H24	Se	P	12.4	2.9	7.5	1.5	3.9
A1	C	P	12.2	1.1	8.3	1.4	3.6
A2	C	P	9.3	4.4	9.7	1.0	3.9
A3	C	P	13.6	3.7	8.9	1.3	3.9
A4	C	G	17.8	4.3	9.0	2.0	4.4
A5	C	G	20.3	0.9	9.2	2.5	4.2
A6	C	G	18.6	1.8	6.4	0.4	3.6

* Lines 5 and 6 omitted in high-school and adult averages. G=Good; P=Poor.

ANALYSIS OF EYE-VOICE SPAN

An interpretation of the significance of the variations in eye-voice span can best be made by studying the relationships between these variations and other known factors of the reading process. A large amount of valuable information has been developed in recent years concerning reading rate and quality, and the characteristics of eye-movements and fixations. A correlation of the eye-voice span with some of the known factors will determine which types of eye-voice separation are indicative of mature and of immature reading habits. Accordingly, an analysis of the eye-voice span will be made showing correlations (*a*) with quality of reading throughout the school period, (*b*) with various positions in the sentence, (*c*) with reading rate, (*d*) with the number of fixations, and (*e*) with regressive movements. After such an analysis the significance of the eye-voice span can be more definitely stated.

Relation to quality of reading throughout the school grades.—The subjects for this experiment were carefully selected, as stated in an earlier paragraph, on the basis of quality of reading, making two equal groups, one composed of good readers and the other of poor readers. By comparing the average eye-voice spans of these two groups the correlation with quality of reading becomes apparent. The subjects were also selected from each elementary grade above the second and from each high-school class. The purpose of this method of selection was to make possible a study of the development of the eye-voice span through the grades. Table II shows the average eye-voice span of twenty-four elementary pupils by school grades and also by quality of reading. Figure 1 expresses the same facts graphically. The table shows the average eye-voice span for all the good readers to be 13.8 letter-spaces, for the poor readers 8.7 letter-spaces, and for the whole group of 24 pupils taken together 11.3 letter-spaces. The superiority of the good

TABLE II

AVERAGE EYE-VOICE SPAN BY GRADES—ELEMENTARY SUBJECTS

SUBJECTS	GRADE						AVERAGE FOR ALL GRADES
	II	III	IV	V	VI	VII	
Good readers.....	11.0	13.2	13.9	16.8	11.9	15.9	13.8
Poor readers.....	5.4	10.3	6.1	9.7	11.2	9.4	8.7
Good and poor...	8.2	11.8	10.0	13.3	11.6	12.7	11.3

readers in width of eye-voice span is very great, the average for all grades being 58 per cent wider than that of the poor readers. The average span of the good readers is also wider than that of the poor readers in every grade, being greater by 103 per cent in the second grade, 28 per cent in the third grade, 127 per cent in the fourth grade, 73 per cent in the fifth, 6 per cent in the sixth, and 69 per cent in the seventh. These results make it perfectly clear that for elementary pupils a wide eye-voice span is a factor of good reading and a narrow span is a factor of poor reading. Whether this factor is in the nature of a cause or an effect will be considered later.

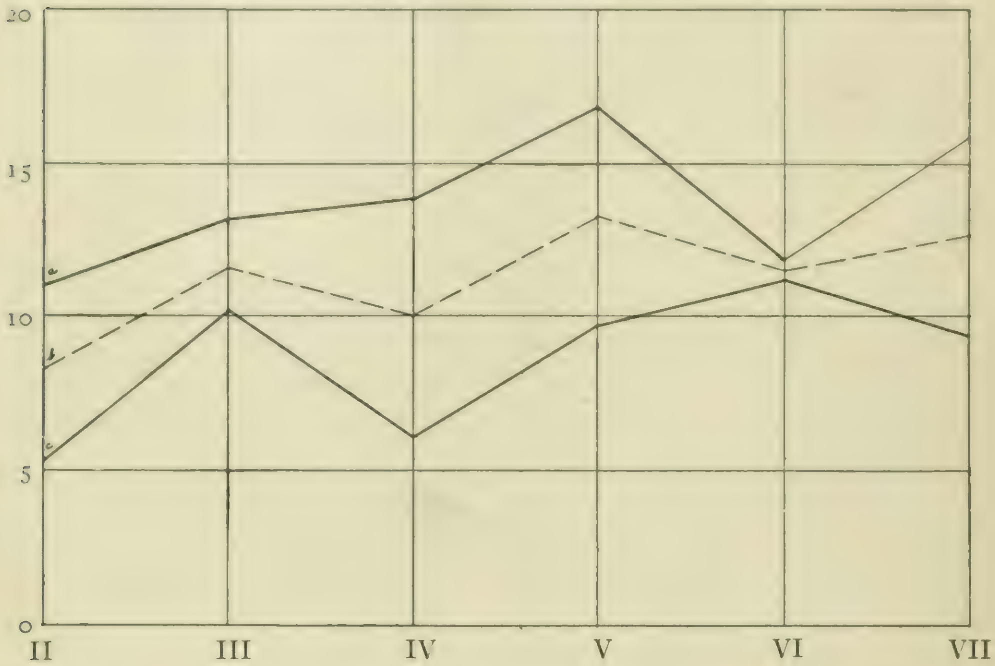


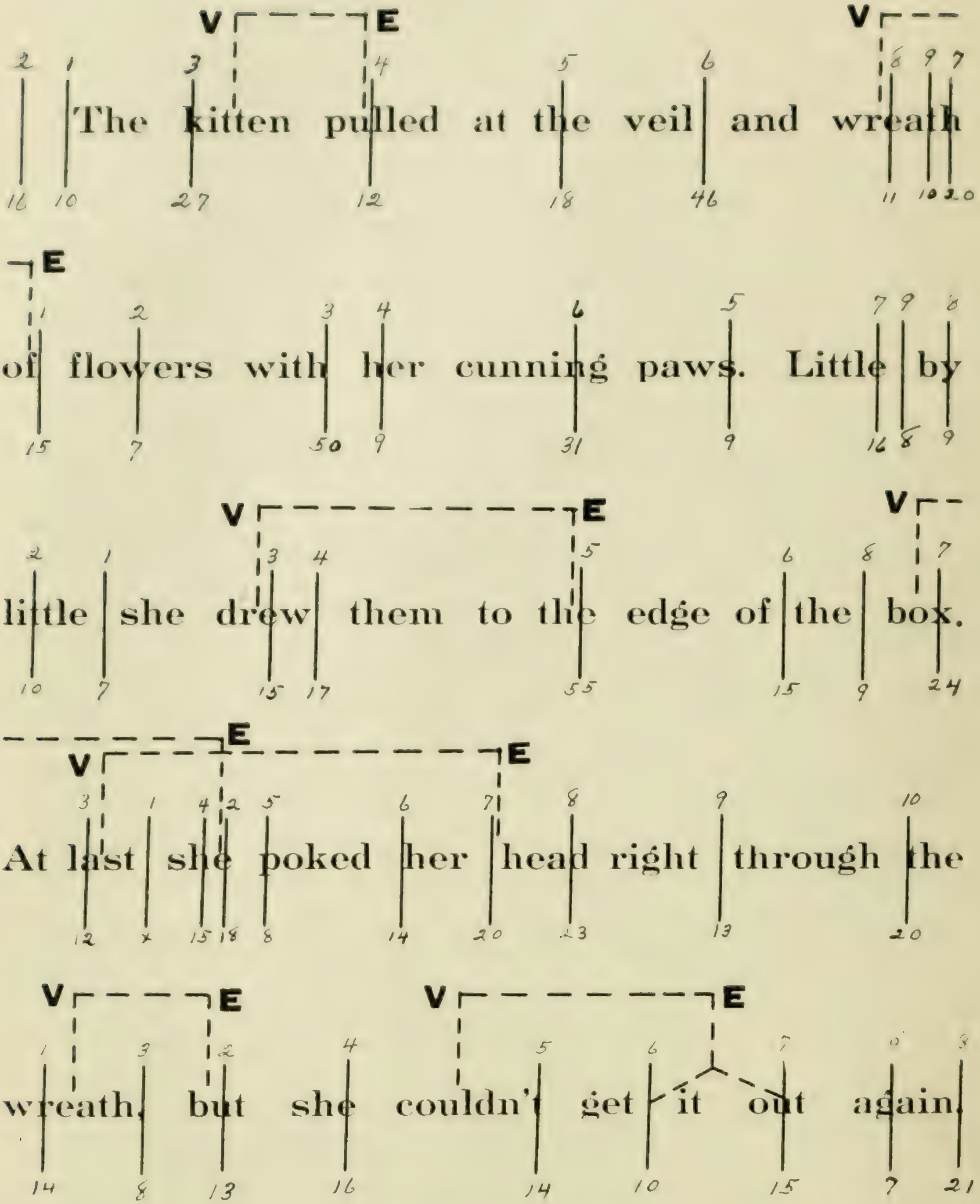
FIG. 1.—Average eye-voice span by grades—elementary subjects. The grades are shown on the horizontal axis. The width of the eye-voice span in letter-spaces is shown on the vertical axis.

A development in the width of the eye-voice span through the grades is also shown by Table II and Figure 1. Following the upper line in Figure 1, for the good readers, the progress shows a general upward direction until the sixth grade is reached, where a sudden drop occurs. This drop is apparently due to a very extreme variation in a single individual rather than to a characteristic of the grade in general. Subject E18, who was a good reader in the sixth grade, had an average eye-voice span which was lower than that of any other good reader, even those in the second grade. The low average of the good readers for this grade is due to this exceptionally narrow span. This subject showed all the other characteristics of a good reader, and no explanation appeared, as far as could be discovered, for the very narrow span except that it was an extreme individual variation. The development of the span through the grades for both good and poor readers was irregular, but a general upward tendency of the line is noticeable. Evidently this development is interfered with in the training of some pupils.

Plates III and V–XV show the readings of one good and one poor reader from each of the elementary grades. A study of some of these individual records will reveal many characteristic variations in oral reading. Plates V and VI give the readings of a good and a poor reader from the second grade. Subject E2, the good reader, has an average span of 10.3 letter-spaces. The width of the span in the two positions measured in the first line is much narrower than in the positions in the third and fourth lines. Such a variation for a subject, within a selection, is a characteristic in some degree of all readers. Plate VI shows the reading of Subject E3, a second-grade pupil and the poorest reader tested. The whole character of his eye-movements is different from that of E2. The average eye-voice span of E3 is only 3.4 letter-spaces. In the first line for the second word there was no span at all, the eye being fixated upon the word "kitten" at the same time it was being spoken. At the beginning of the fourth line a span of only 3 letter-spaces is found. The dictaphone record showed that this subject did not know all of the words of the selection and had not mastered his phonics sufficiently to help himself. Several words were apparently spelled out before they were pronounced. It is plainly evident that reading for this subject was little more than pronouncing a series of words. He was unable to look ahead of his voice and therefore had no means of grasping the meaning of a sentence in more than word units. This was a very extreme case which should doubtless receive special treatment.

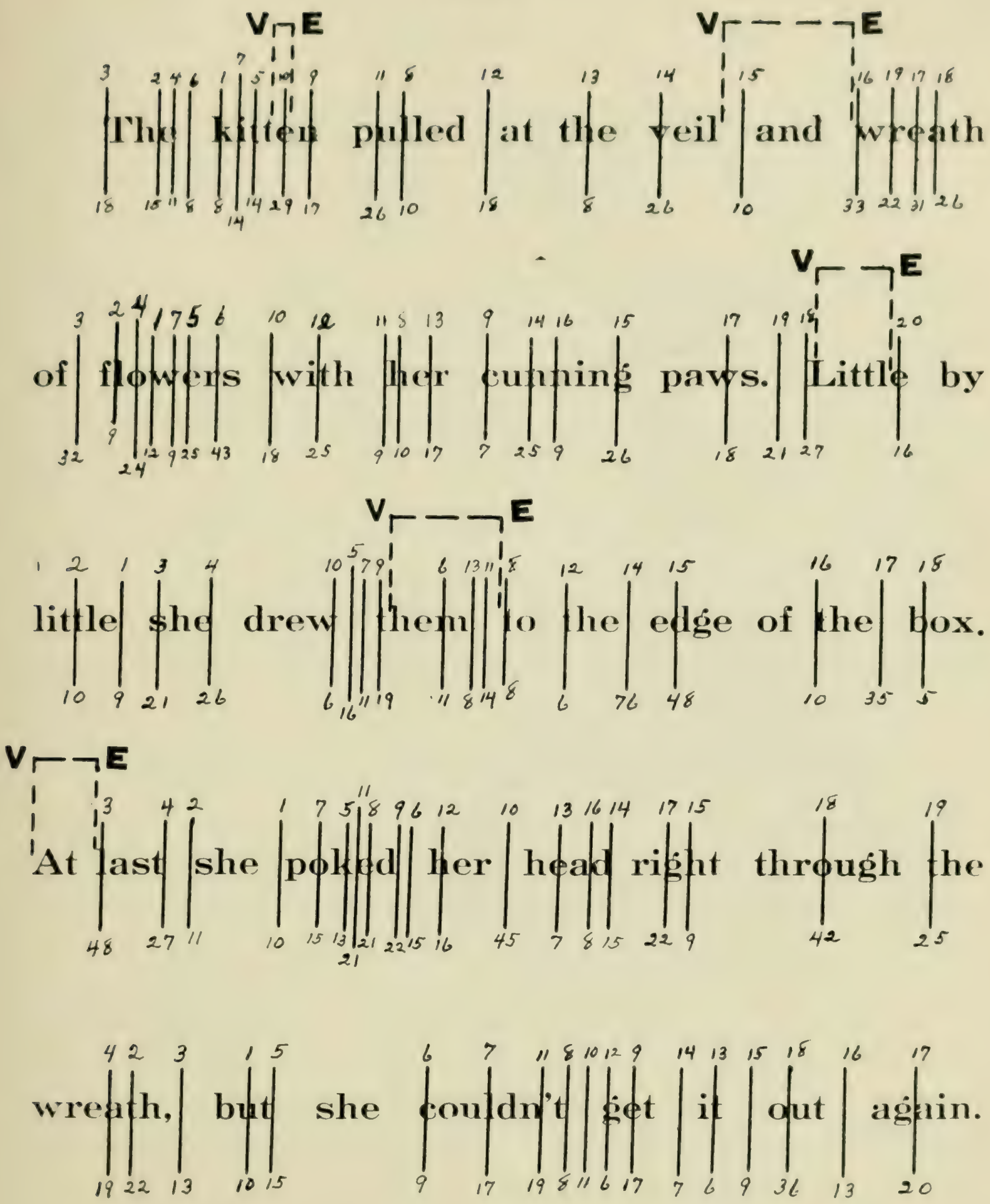
Plates VII and VIII show the records of a good and a poor reader from the third grade. The good reader, Subject E6, has an average span of 13.7 letter-spaces. In line 3 there was a large span of 20 letter-spaces. Subject E7, the poor reader, was a very active and talkative boy when not engaged in reading. He read as if the whole process were a bore to him and gave clear evidence that he did not hold the ability to read well in very high esteem. He had a very difficult time stumbling through the first line, making 29 fixations in the process. His average

PLATE V


The kitten pulled at the veil and wreath
of flowers with her cunning paws. Little by
little she drew them to the edge of the box.
At last she poked her head right through the
wreath, but she couldn't get it out again.
V
E

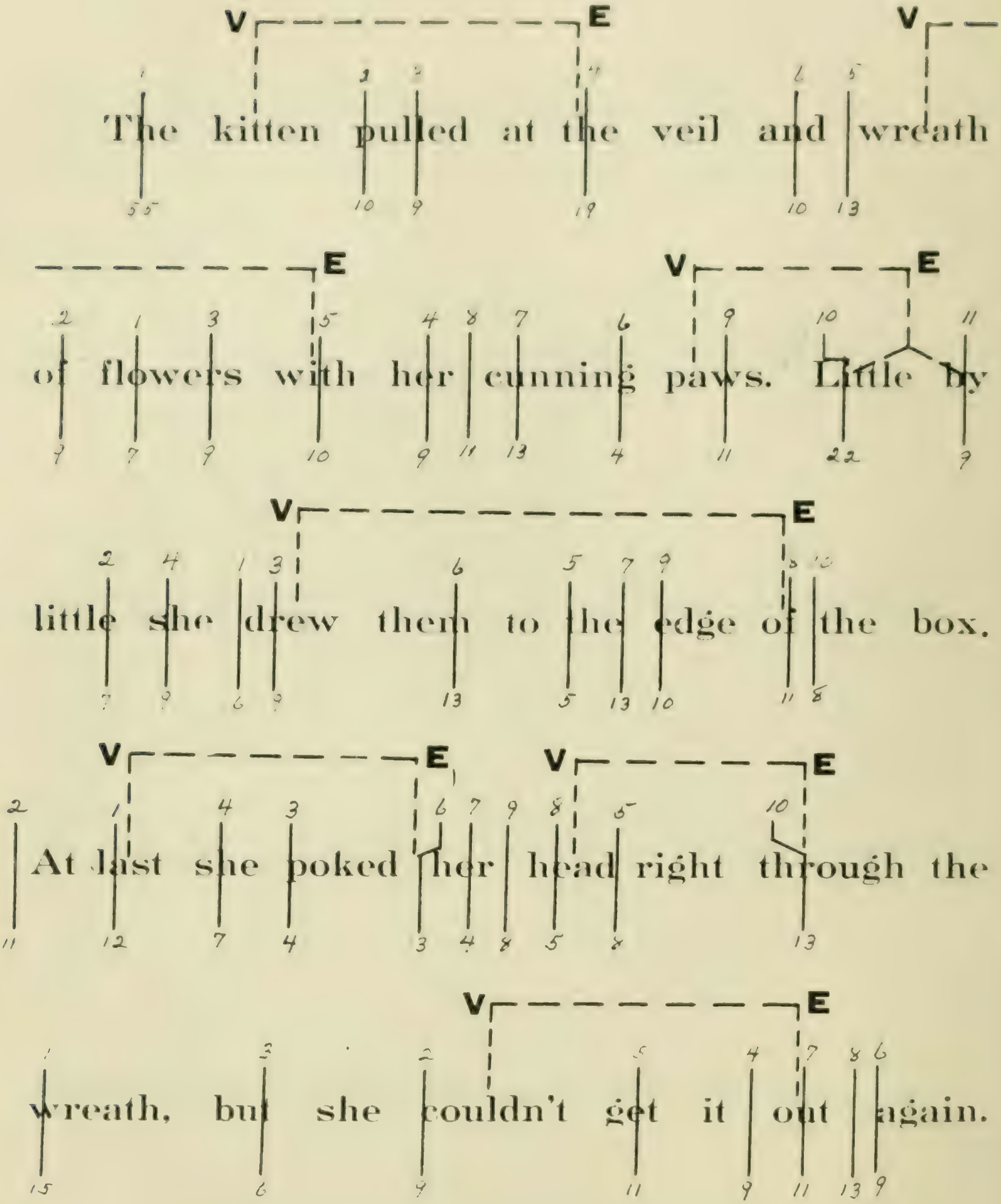
Eye-voice span of Subject E2, good reader, Grade II

PLATE VI


V E
The kitten pulled at the veil and wreath
V E
of flowers with her cunning paws. Little by
V E
little she drew them to the edge of the box.
V E
At last she poked her head right through the
wreath, but she couldn't get it out again.

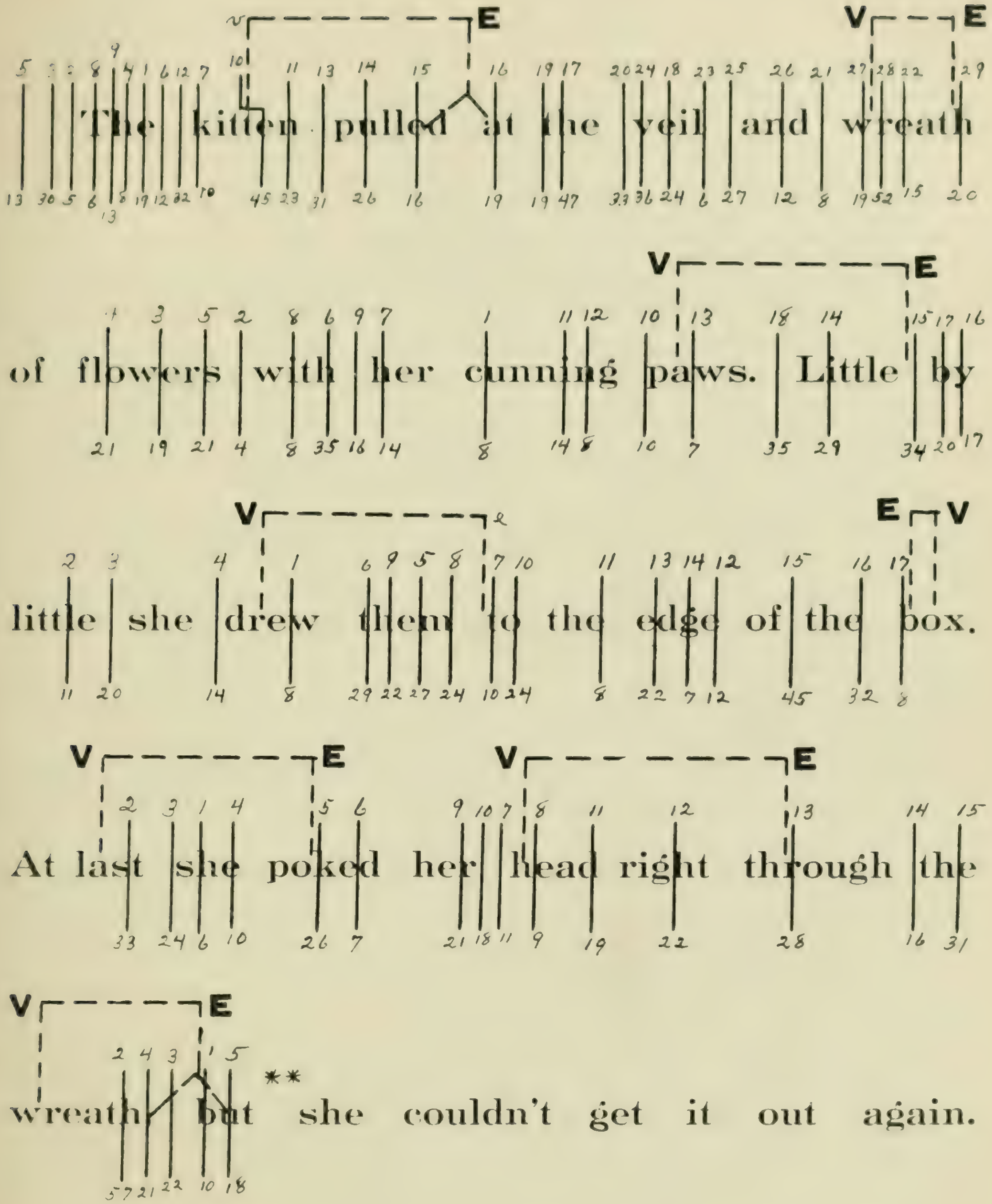
Eye-voice span of Subject E3, poor reader, Grade II

PLATE VII


V E V
The kitten pulled at the veil and wreath
E V E
of flowers with her cunning paws. Little by
V E
little she drew them to the edge of the box.
V E V E
At last she poked her head right through the
V E
wreath, but she couldn't get it out again.

Eye-voice span of Subject E6, good reader, Grade III

PLATE VIII


V E V E
The kitten pulled at the veil and wreath
V E
of flowers with her cunning paws. Little by
V E V
little she drew them to the edge of the box.
V E V E
At last she poked her head right through the
V E
wreath but ** she couldn't get it out again.

Eye-voice span of Subject E7, poor reader, Grade III. (**—end of film) eye-voice span was 8 letter-spaces. On the word "box" in the third line his span was reduced to zero.

Plate IX shows the record of a good reader in the fourth grade. That of the poor reader from this grade was given in Plate III. The good reader, Subject E9, had an eye-voice span of 11.1 letter-spaces. His record shows a distinct difference in the length of the span at the ends of the first two sentences, on the words "paws" and "box." These relatively shorter spans on the last word of a sentence are much more noticeable with a good reader than with a poor one.

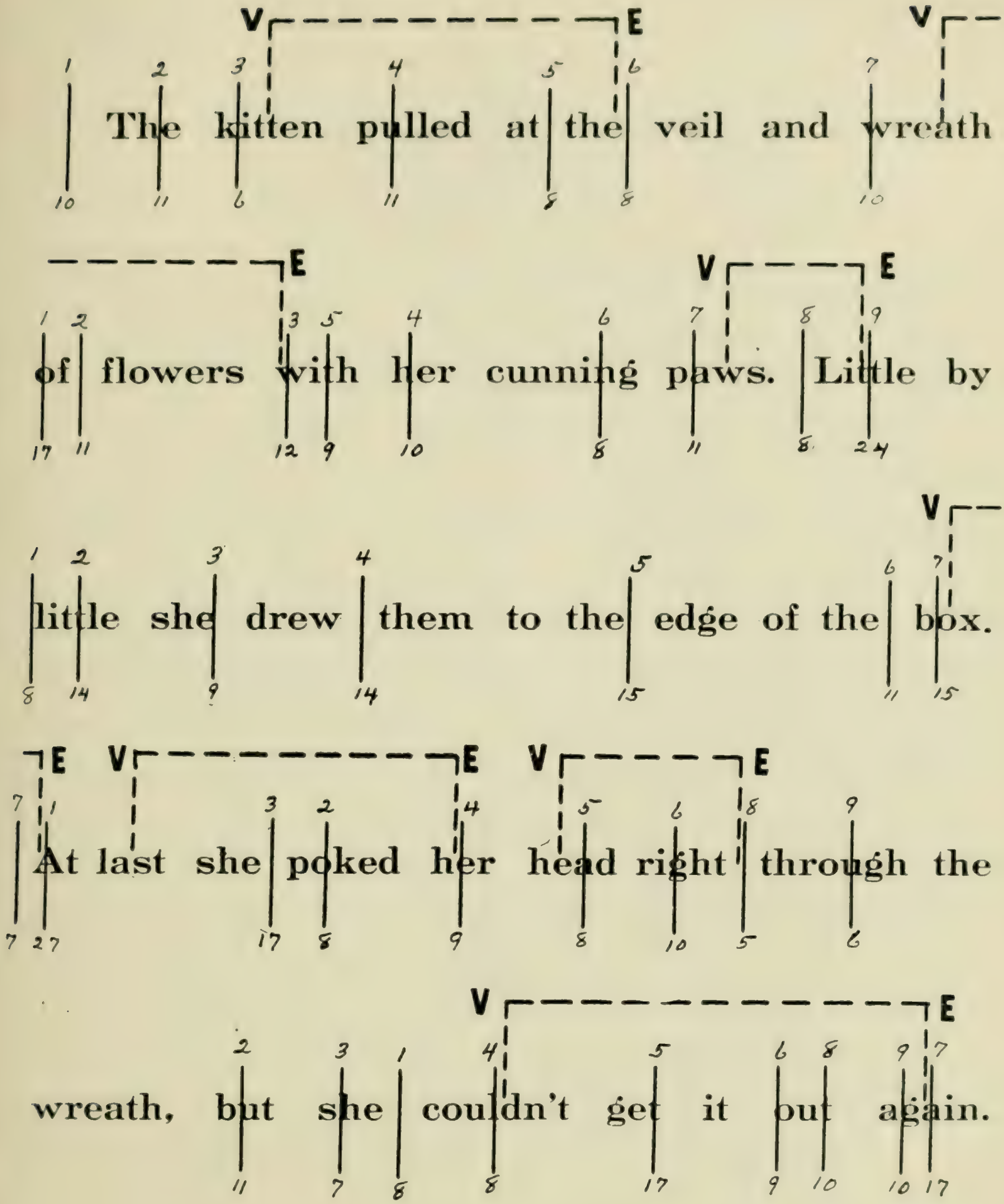
Plate X shows the record of a good reader from the fifth grade, who has an exceptionally wide eye-voice span which averages 19.7 letter-spaces. When this subject was pronouncing the word "head" in the fourth line, the eye was fixated just after the word "wreath" in the last line, making a span of 26 letter-spaces. Such a wide eye-voice span gives the reader a large opportunity to anticipate and interpret the meaning of the sentence in large units, and allows a much more expressive oral presentation than could be given without such a wide span.

Plate XI shows the record of a poor reader from this same grade, with an average span of only 7 letter-spaces. A comparison of these two records will readily show the handicap under which a person with a short span reads.

Plates XIV and XV show the wide variation in the reading of two seventh-grade pupils. Subject E22, in Plate XIV, has an average eye-voice span of 19.7 letter-spaces. The second fixation in the last line of this plate shows a type of eye-movement which occurs frequently in the reading of all subjects. It will be noticed that the first fixation falls upon the first word of the line, while the second appears to fall just before the last word. A careful examination of the film shows that an upward movement of the eye was made between fixations 1 and 2 and that the eye was really refixated upon the latter part of the preceding line.

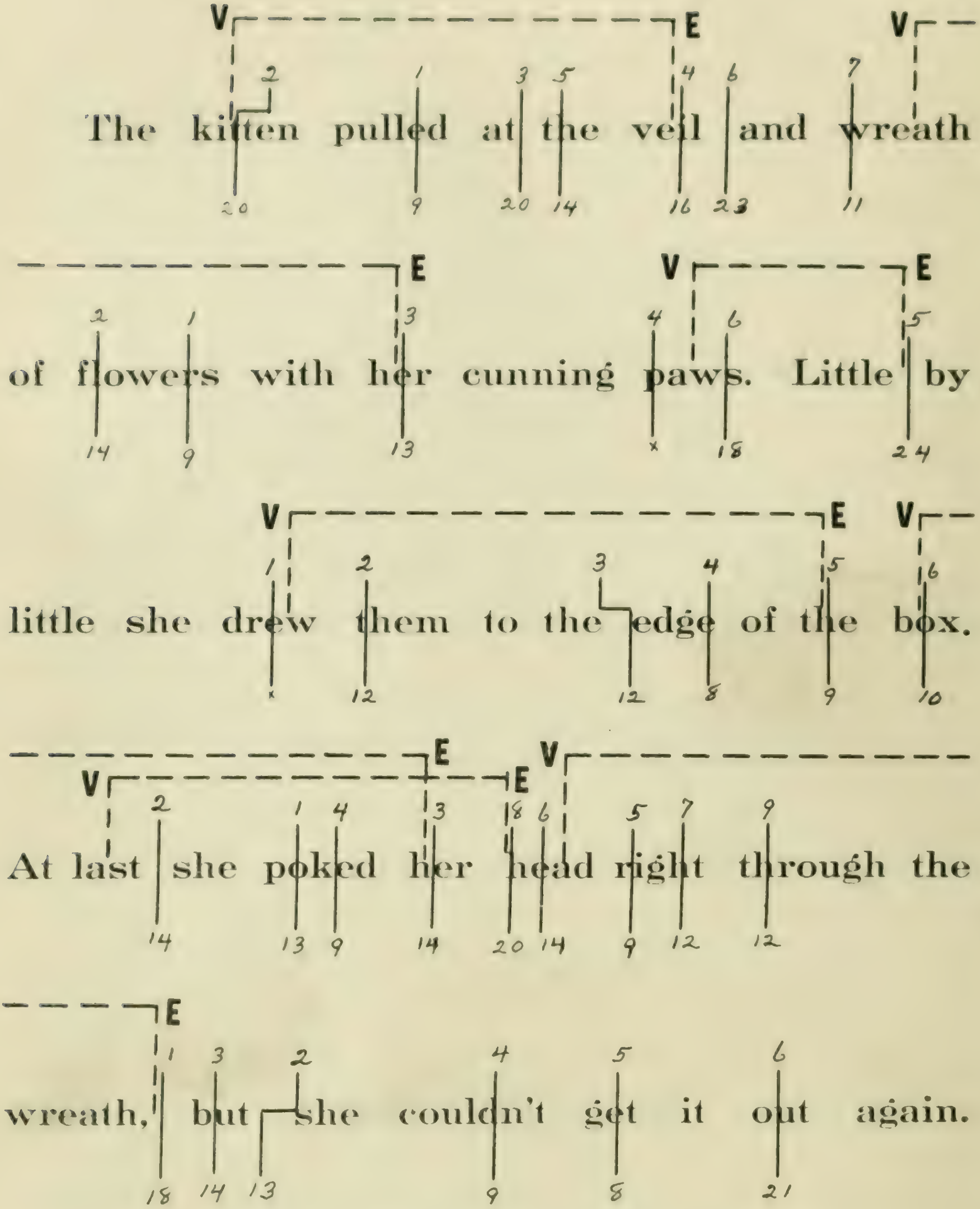
Since the film passed through the camera in the vertical plane, the vertical movements of the eye would not appear directly. The method of determining an upward movement of the eye in this case needs further explanation. The film passed through the camera in a downward direction. A horizontal eye movement from the end of one line to the beginning of the next would appear as an oblique line, due to the fact that the eye moves *down* to the next line while the film is also moving in the same direction. If the eye moved from one end of a line to the other end of the same line, the degree of obliqueness would be less

PLATE IX


The kitten pulled at the veil and wreath
of flowers with her cunning paws. Little by
little she drew them to the edge of the box.
At last she poked her head right through the
wreath, but she couldn't get it out again.
V
E

Eye-voice span of Subject E9, good reader, Grade IV

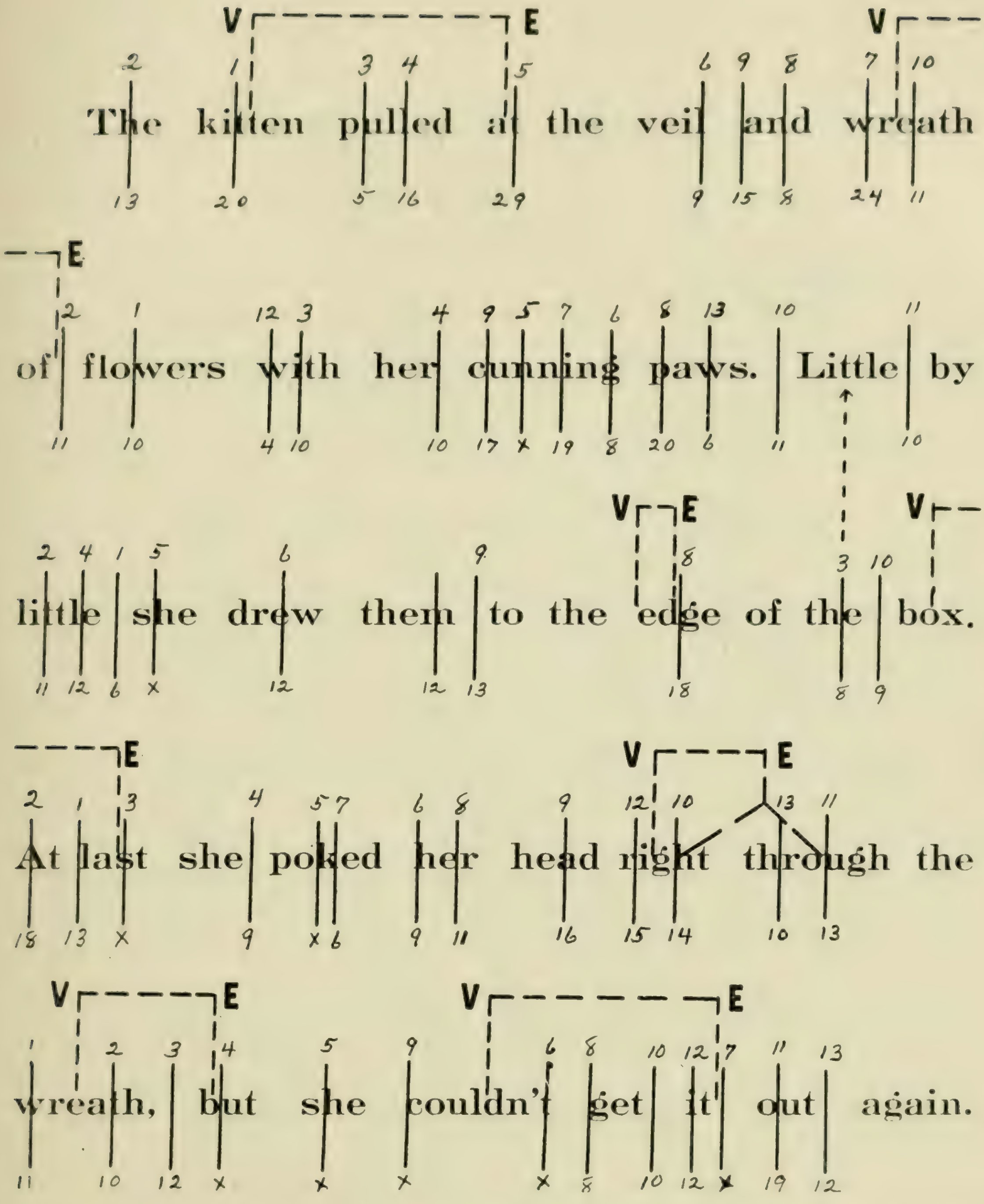
PLATE X



The kitten pulled at the veil and wreath
of flowers with her cunning paws. Little by
little she drew them to the edge of the box.
At last she poked her head right through the
wreath, but she couldn't get it out again.

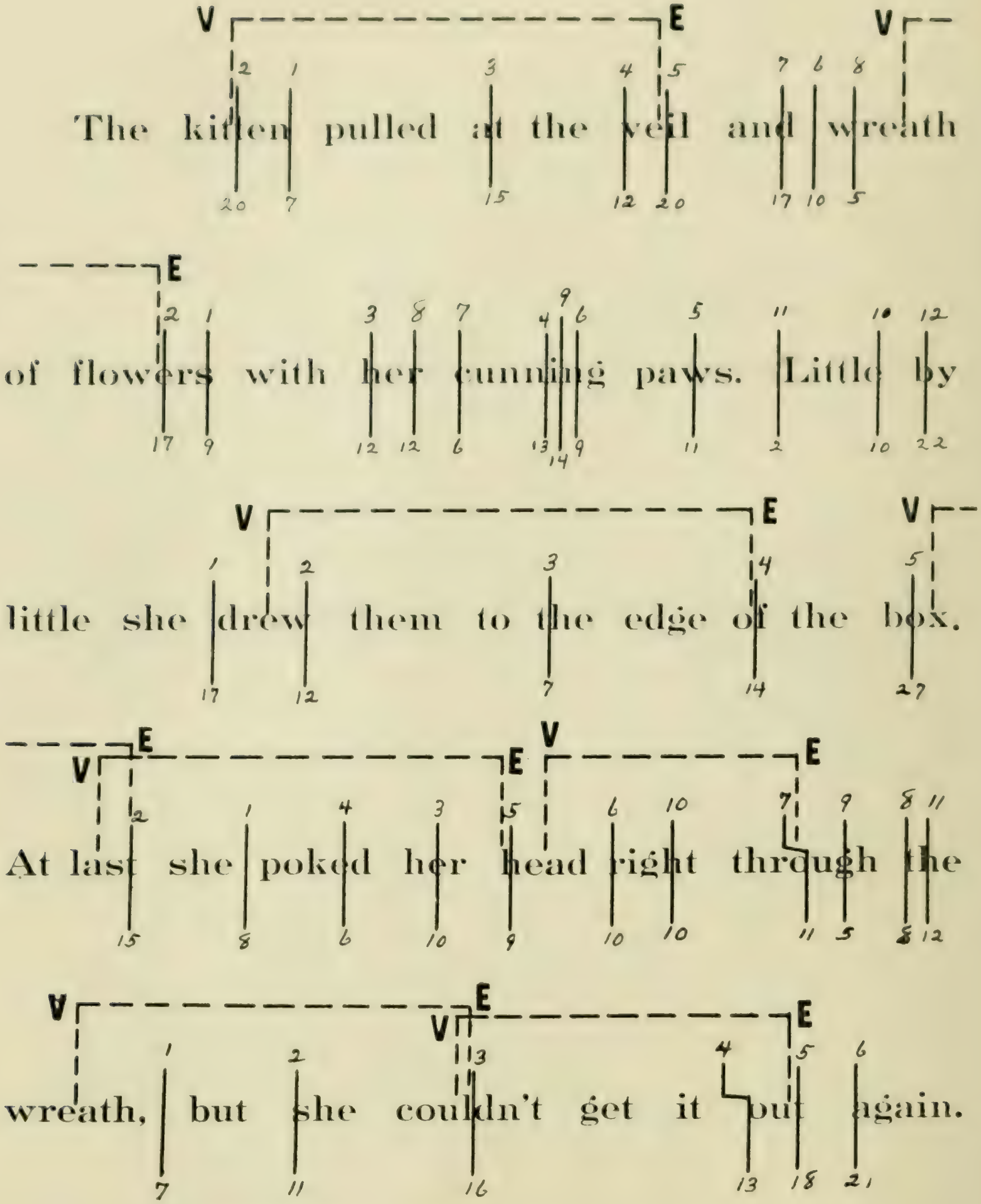
Eye-voice span of Subject E13, good reader, Grade V

PLATE XI


V E V
2 1 3 4 5 6 9 8 7 10
The kitten pulled at the veil and wreath
13 20 5 16 29 9 15 8 24 11
E
2 1 12 3 4 9 5 7 6 8 13 10 11
of flowers with her cunning paws. Little by
11 10 4 10 10 17 x 19 8 20 6 11 10
V E V
2 4 1 5 6 9 8 3 10
little she drew them to the edge of the box.
11 12 6 x 12 12 13 18 8 9
E V E
2 1 3 4 5 7 6 8 9 12 10 13 11
At last she poked her head right through the
18 13 x 9 x 6 9 11 16 15 14 10 13
V E V E
1 2 3 4 5 9 6 8 10 12 7 11 13
wreath, but she couldn't get it out again.
11 10 12 x x x x 8 10 12 x 19 12

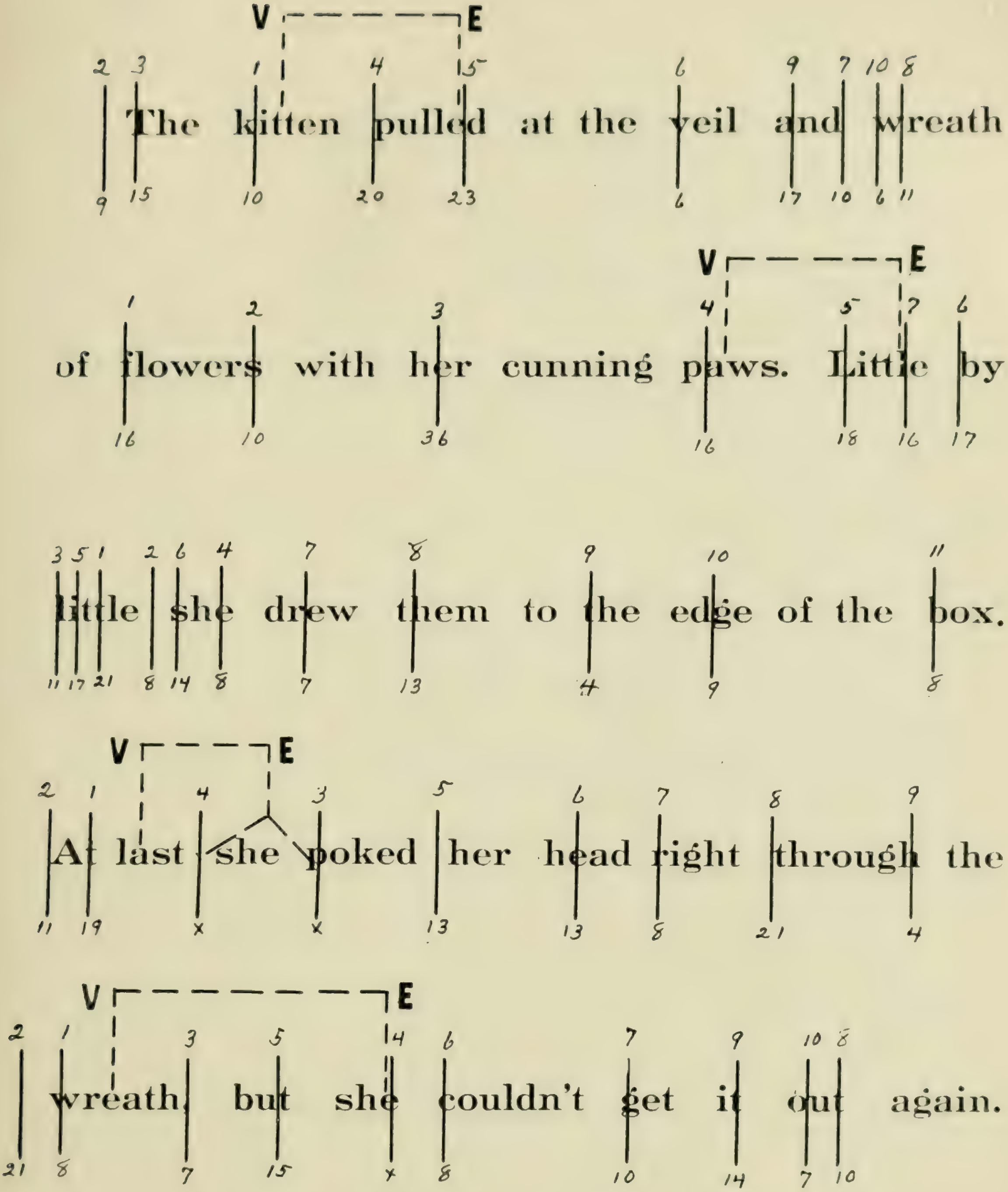
Eye-voice span of Subject E16, poor reader, Grade V. The mark *x* in this and following plates indicates that it was impossible to determine with precision the length of the fixation.

PLATE XII



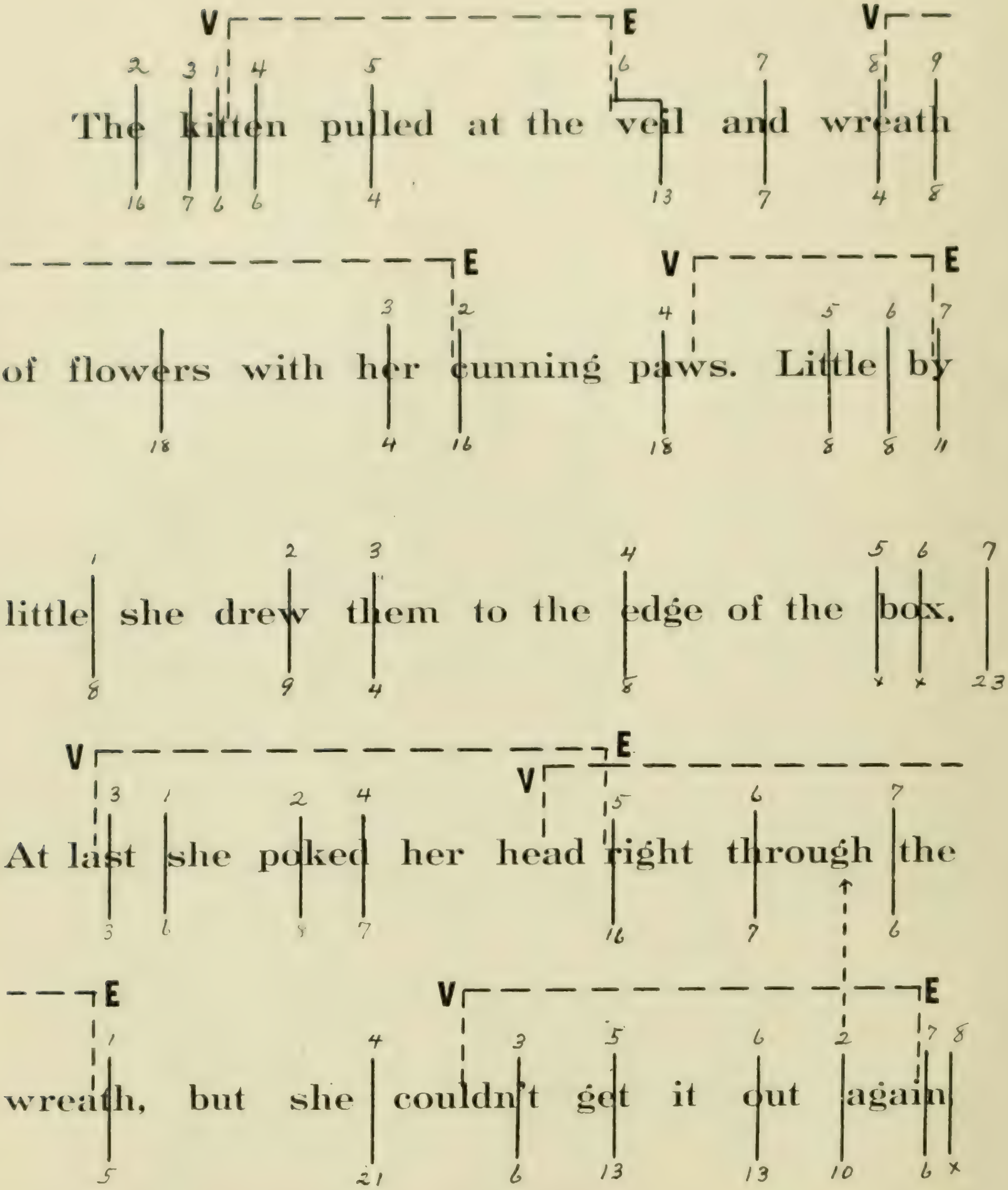
Eye-voice span of Subject E17, good reader, Grade VI

PLATE XIII



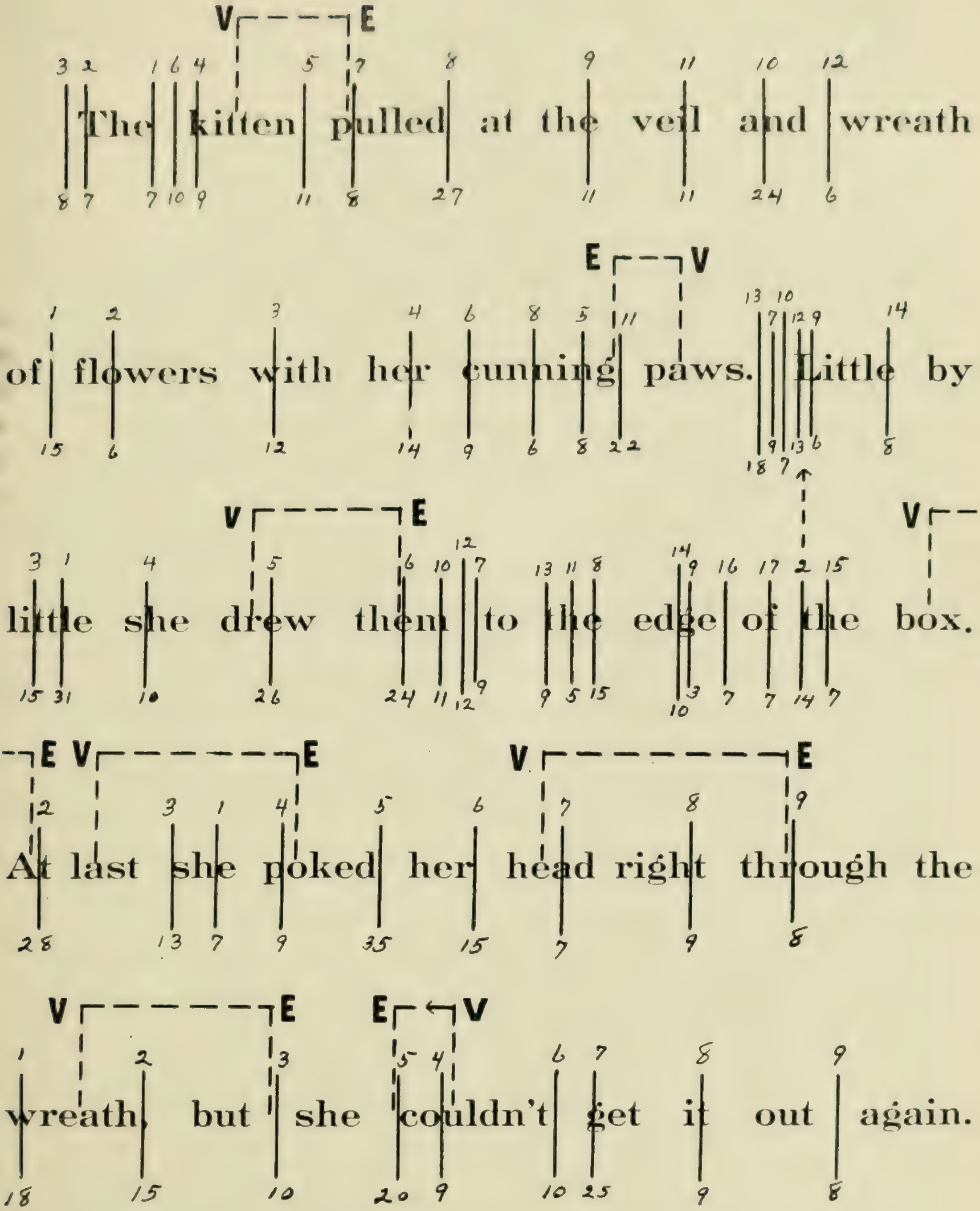
Eye-voice span of Subject E19, poor reader, Grade VI

PLATE XIV


The kitten pulled at the veil and wreath
of flowers with her cunning paws. Little by
little she drew them to the edge of the box.
At last she poked her head right through the
wreath, but she couldn't get it out again
V
E

Eye-voice span of Subject E22, good reader, Grade VII

PLATE XV


The kitten pulled at the veil and wreath
of flowers with her cunning paws. Little by
little she drew them to the edge of the box.
At last she poked her head right through the
wreath, but she couldn't get it out again.
V
E

Eye-voice span of Subject E24, poor reader, Grade VII because there would be no added drop of the eye to the line below. The movement to the second fixation in the last line of Plate XIV not only failed to show an oblique in the downward direction, but it showed a slight oblique in the upward direction. The only possible explanation is that the eye was raised a little more than was necessary to overcome the downward movement of the film. A careful examination of the film shows that, when compared to the degree of slant of a movement of the eye across the same line, the upward movement in this case is approximately equal to the added downward movement when the eye makes its regular drop from line to line. This would locate the fixation following the upward oblique on the line above. This is indicated in the plates by a dotted line above the fixation point, showing that a regressive movement was actually made to the preceding line, although it appears at first glance to be a long movement in the forward direction.

A similar regressive movement is seen in the second fixation of line 3 in Plate XV. Such fixations are sufficiently frequent to indicate that the transition from line to line presents a difficulty to some readers.

Subject E24, in Plate XV, was an exceedingly poor reader for the seventh grade. In lines 2 and 5 his record shows the curious situation of having the eye behind the voice. In both cases this is due to a regressive movement which occurred as the measure was taken. The reading of this subject was poorer than that of the two better readers in the second grade and his eye-voice span was also narrower.

The average eye-voice span for the twenty-four high-school subjects is given in Table III. The same facts are expressed graphically in Figure 2. Here again the greater width of the span for the good readers is made clear. In the freshman class the average eye-voice span of the good readers was greater by 37 per cent, in the sophomore class by 16 per cent, in the junior class by 74 per cent, and in the senior class by 28 per cent. For the total group of high-school subjects the average span of the good readers exceeds that of the poor readers by 36 per cent. This evidence is in agreement with that from the elementary-school pupils, and clearly shows a high degree of correlation between good reading and a wide eye-voice span.

The consistent development in the width of the eye-voice span through the high-school grades is not so evident as in the lower grades. The good readers from the freshman class have a wider span than those from the sophomore and junior classes, and one practically equal to that of the senior class. The average span for the poor readers from the junior class is lower than that of any of the other three. These differences may be accounted for by the fact that in high school little attention is given to reading as a special subject of instruction above the freshman year. The freshman class had been undergoing a series of experimental training exercises conducted by the English department.

TABLE III

AVERAGE EYE-VOICE SPAN BY GRADES—HIGH-SCHOOL SUBJECTS*

SUBJECTS	GRADE				AVERAGE FOR ALL GRADES
	9	10	11	12	
	Freshman	Sophomore	Junior	Senior	
Good readers	15.8	14.5	14.6	15.9	15.2
Poor readers	11.5	12.5	8.2	12.4	11.2
Good and poor	13.7	13.5	11.4	14.2	13.2

* Data for lines 5 and 6 not included.

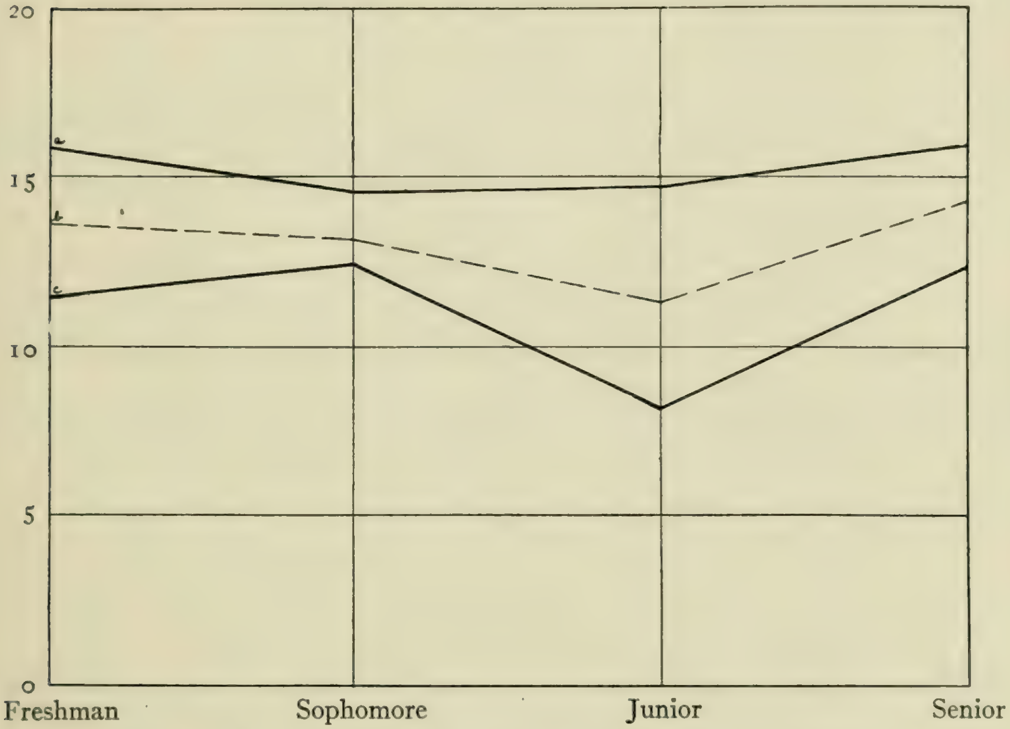


FIG. 2.—Average eye-voice span by grades—high-school subjects

This special training probably accounts for the superiority of the pupils in this class.

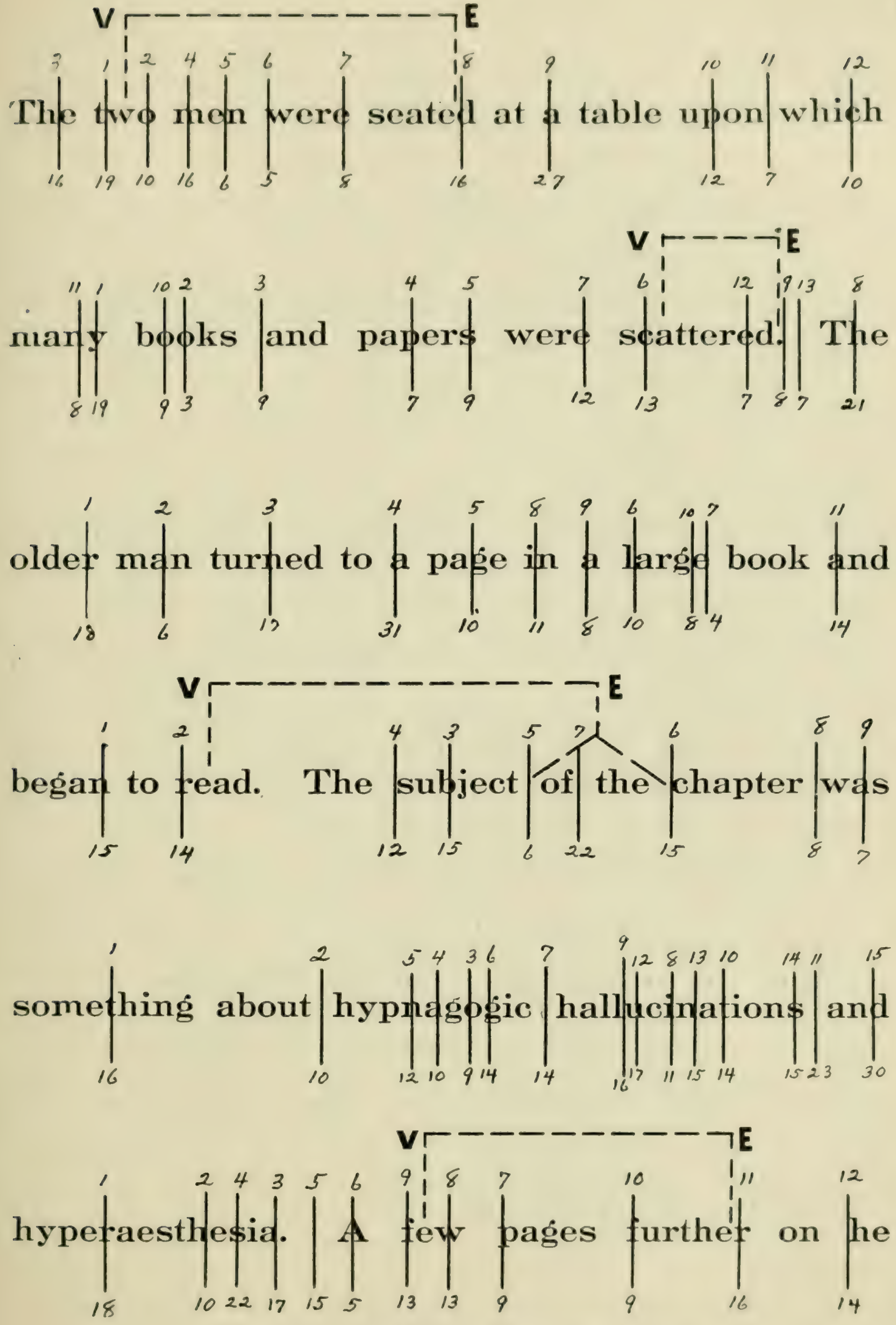
Plates IV and XVI–XX show representative readings of high-school subjects. The record of a good reader from the freshman class, with an average span of 14.3 letter-spaces, is given in Plate IV. The span for this subject is quite regular, showing little variation in any of the eight positions measured. Plate XVI gives the record for a poor reader from the same grade. The average eye-voice span for this reader is 12.4 letter-spaces. The last half of the record for a good reader from the junior class is shown in Plate XVII. This subject had an average span of 17.7 letter-spaces. The ease with which he read the sentence in quotations shows that if the words are simple, it is unnecessary to understand the thought in order to read in a normal fashion. This subject certainly had no idea of the way "the original elements of our consciousness grew up," and yet he read the sentence in the same manner in which he read the first four easy lines. A record of a poor reader from the junior class is given in Plate XVIII. The width of the average span for this subject is only 8.5 letter-spaces, and shows considerable variation throughout the selection. Plates XIX and XX show the records of a good and a poor reader from the senior class having little difference in the average width of their eye-voice span.

On the whole there was less difference in the width of span between the good and poor readers in the high school than in the elementary grades. This is to be expected, since even a poor high-school reader does fairly well. The poorest readers of the elementary school are probably eliminated and never reach high school.

The group of six college students had a development of the eye-voice span beyond that of the high-school group. The average span for the good adult readers is 18.9 letter-spaces, for the poor readers 11.7 letter-spaces, and for the group as a whole 15.3 letter-spaces. The difference between the good and poor readers is again very large.

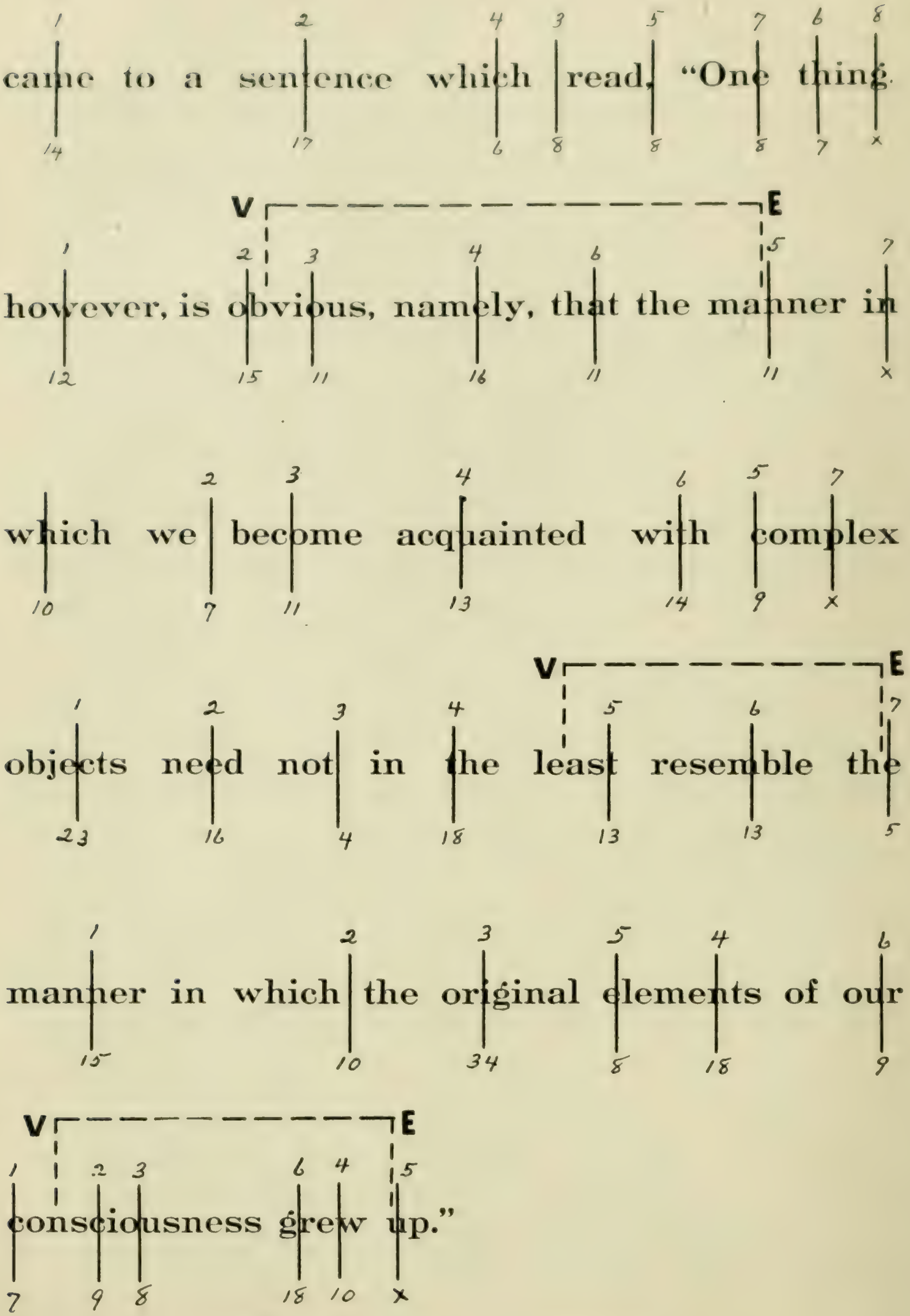
The development of the eye-voice span for the entire fifty-four subjects is shown in Figure 3. The upper solid line represents the twenty-seven good readers, the lower solid line the twenty-seven poor readers, and the middle broken line the good and poor readers taken together. Following the line for the good readers it will be noticed that the greatest rise in the curve occurs during the second, third, and fourth grades. The average span of the good readers in the fifth grade is wider than that of any other grade. The average span for the fifth-, sixth-, and seventh-grade good readers is 14.9 letter-spaces, while the average for the entire high-school group of good readers is only 15.2. Remembering that the average for the sixth grade is abnormally low, owing to the exceptional variation of a single subject, the results seem to indicate that the eye-voice span should be well developed by the end of the fourth grade. They show positively that it is possible for a fifth-grade

PLATE XVI


V
E
The two men were seated at a table upon which
many books and papers were scattered. The
older man turned to a page in a large book and
began to read. The subject of the chapter was
something about hypnagogic hallucinations and
hyperaesthesia. A few pages further on he

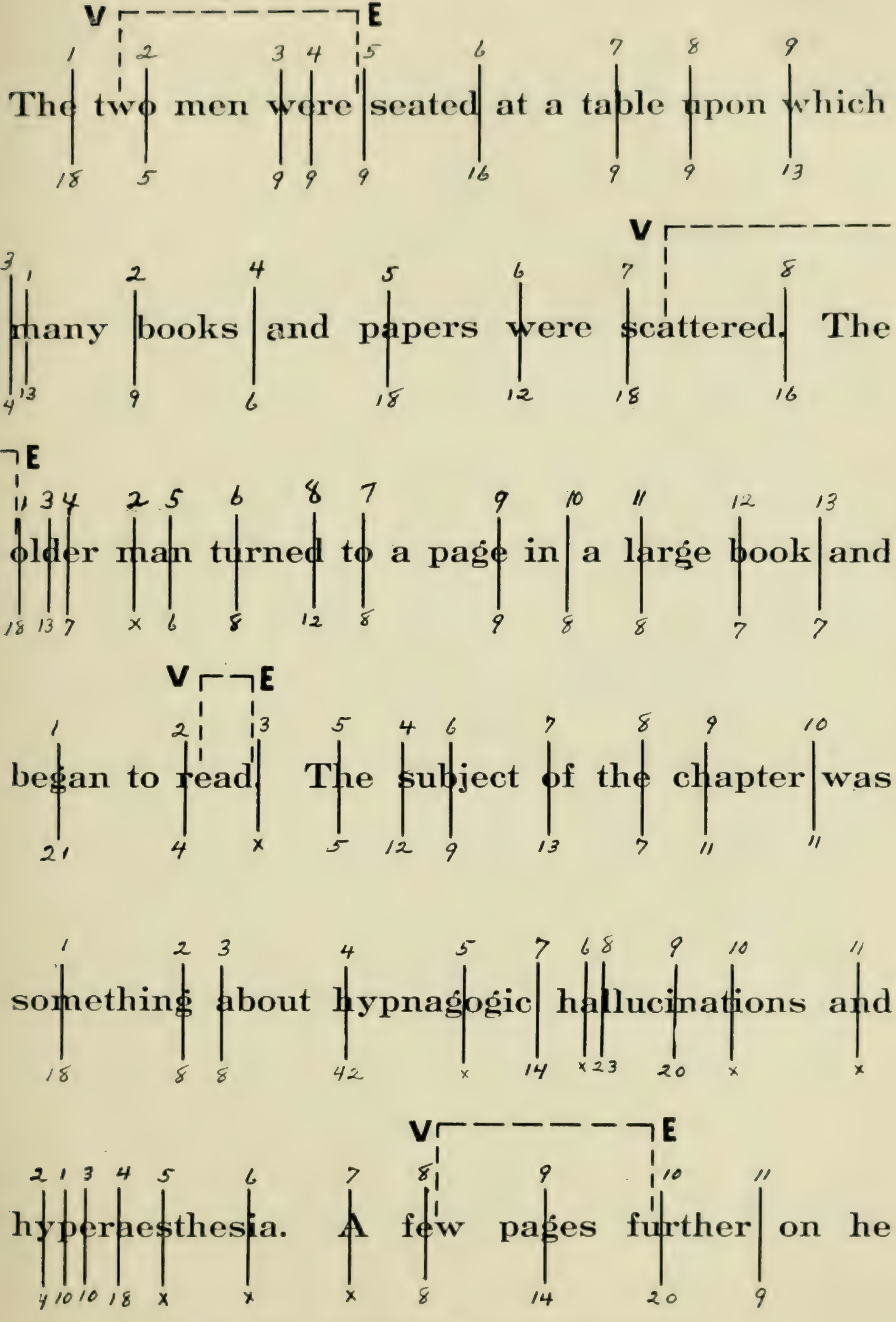
Eye-voice span of Subject H6, poor reader, freshman

PLATE XVII


1 2 4 3 5 7 6 8
came to a sentence which read, "One thing
14 17 6 8 8 8 7 x
V E
1 2 3 4 6 5 7
however, is obvious, namely, that the manner in
12 15 11 16 11 11 x
2 3 4 6 5 7
which we become acquainted with complex
10 7 11 13 14 9 x
V E
1 2 3 4 5 6 7
objects need not in the least resemble the
23 16 4 18 13 13 5
1 2 3 5 4 6
manner in which the original elements of our
15 10 34 8 18 9
V E
1 2 3 6 4 5
consciousness grew up."
7 9 8 18 10 x

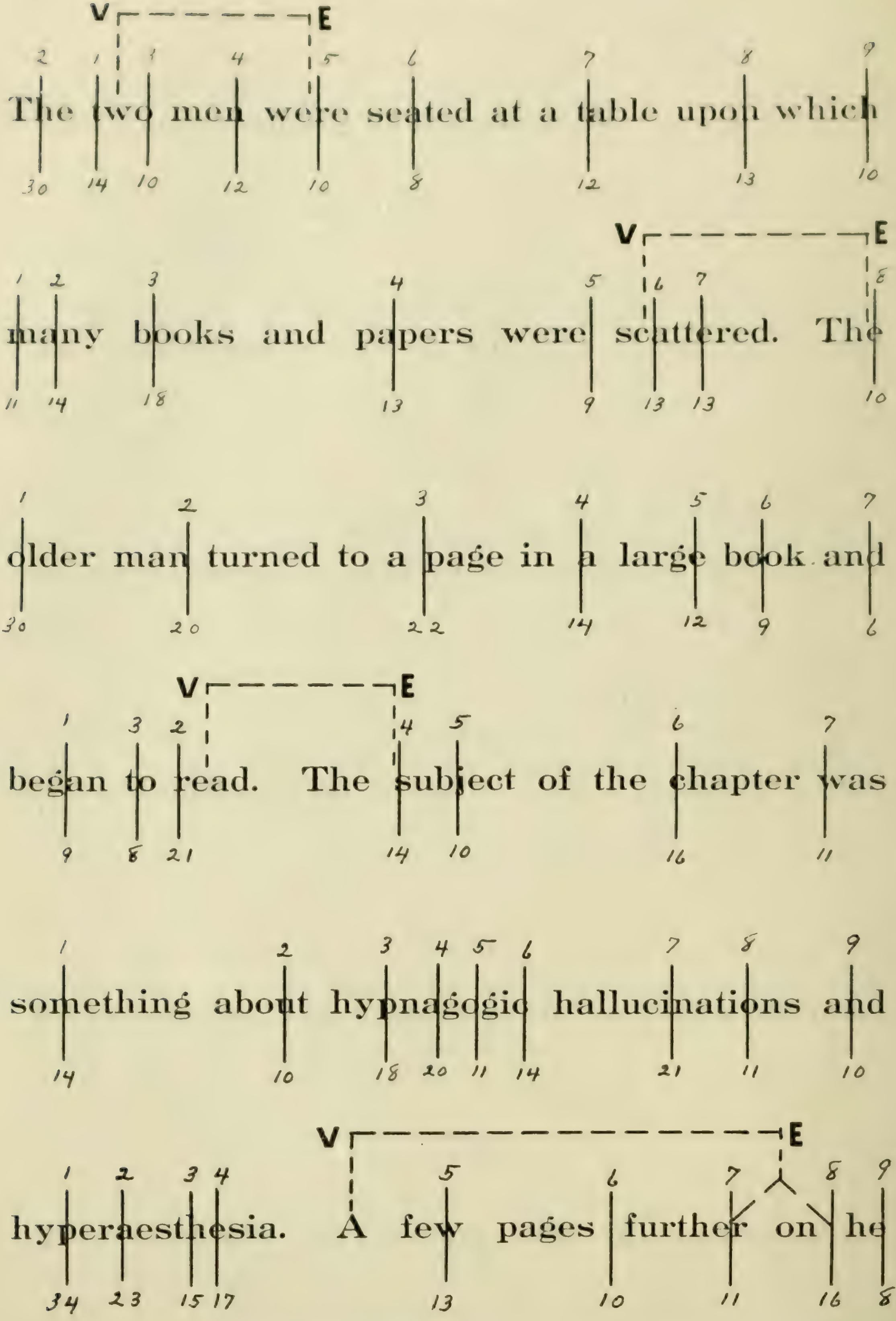
Eye-voice span of Subject H14, good reader, junior

PLATE XVIII


V
E
The two men were seated at a table upon which
many books and papers were scattered. The
older man turned to a page in a large book and
began to read. The subject of the chapter was
something about hypnagogic hallucinations and
hyperaesthesia. A few pages further on he

Eye-voice span of Subject H16, poor reader, junior

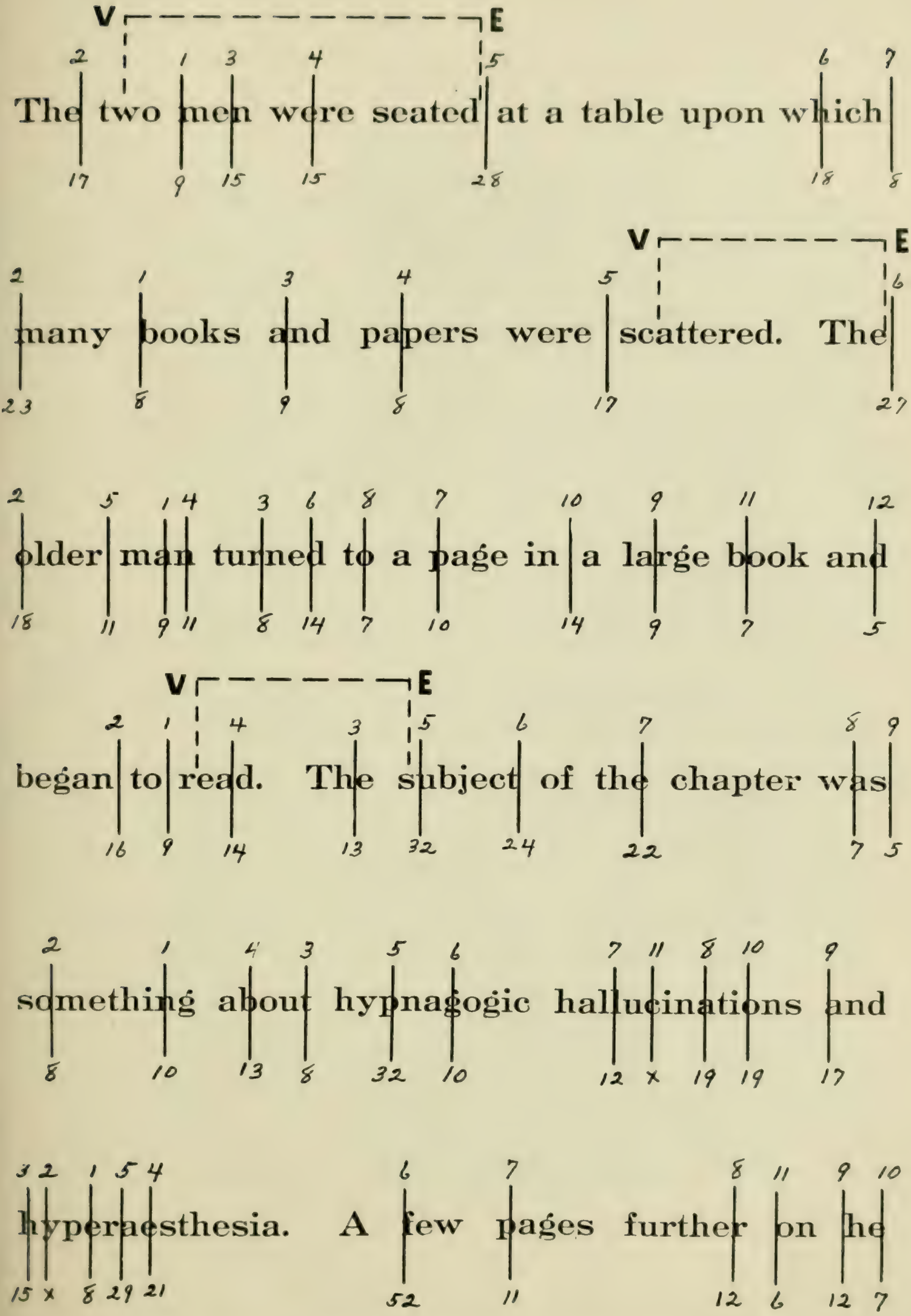
PLATE XIX



The two men were seated at a table upon which
many books and papers were scattered. The
older man turned to a page in a large book and
began to read. The subject of the chapter was
something about hypnagogic hallucinations and
hyperaesthesia. A few pages further on he

Eye-voice span of Subject H19, good reader, senior

PLATE XX


V E
2 1 3 4 5 6 7
The two men were seated at a table upon which
17 9 15 15 28 18 8
V E
2 1 3 4 5 6
many books and papers were scattered. The
23 8 9 8 17 27
2 5 1 4 3 6 8 7 10 9 11 12
older man turned to a page in a large book and
18 11 9 11 8 14 7 10 14 9 7 5
V E
2 1 4 3 5 6 7 8 9
began to read. The subject of the chapter was
16 9 14 13 32 24 22 7 5
2 1 4 3 5 6 7 11 8 10 9
something about hypnagogic hallucinations and
8 10 13 8 32 10 12 x 19 19 17
3 2 1 5 4 6 7 8 11 9 10
hyperaesthesia. A few pages further on he
15 x 8 29 21 52 11 12 6 12 7

Eye-voice span of Subject H24, poor reader, senior

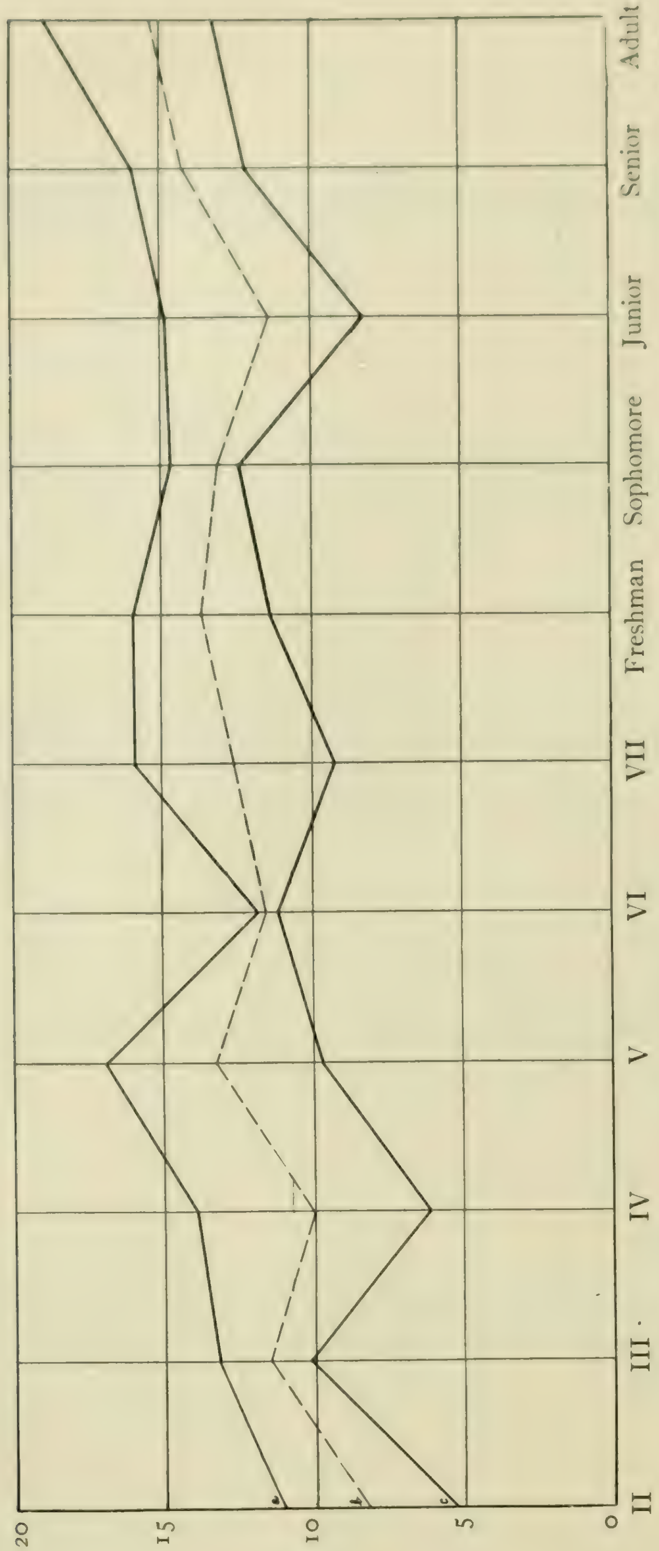


FIG. 3.—Development of eye-voice span—all subjects. Upper line—good readers. Lower line—poor readers. Middle line—both good and poor readers.

reader to maintain an average eye-voice span as wide as the average for any of the school grades above that year. Since the correlation of a wide span with good reading is so clearly shown, it would seem very desirable to give definite training for a wider span in the grades below the fifth.

The line for the poor readers shows on the whole a gradual rise from the second grade to the end of high school. Variations occur in places, but if the curve were smoothed a general rise would appear.

The upward rise of the line for the good readers for the first four grades would indicate a possibility of reaching a maximum eye-voice span during those years, provided specific devices of method for increasing the span could be constructed and applied. The other lines of the curve indicate that at present this is not being accomplished for most of the pupils, but that the span develops gradually throughout the whole school period. This increased emphasis upon the eye-voice span during the first four years would seem to be justified for two reasons. The first is that a wide span is a significant factor in oral reading and these are the years in which the oral method is employed. The second is because, as will be shown more fully in chapter iv, the eye-voice span in oral reading is closely related to the recognition of meaning in silent reading, and whatever benefit might be derived from a wide span in oral reading should be made available for silent reading by the end of the fourth grade.

Regardless of the amount of development through the grades, Figure 3 shows unmistakably that for all grades the good readers have a much wider span than the poor readers. There must be something about a wide eye-voice span which is characteristic of mature reading, and the converse must be true for the narrow span. This matter of the eye-voice span must not be confused with the perception-span. The eye sometimes leads the voice by a distance of several perception-spans. The value of a wide eye-voice span apparently lies in the fact that it allows the mind to grasp and interpret a large meaning unit before the voice must express it.

Relation of eye-voice span to position in sentence.—If the width of the eye-voice span of a single subject is measured at several positions in a selection, it will be found to show considerable variation from point to point. C. T. Gray observed this fact in his study but did not attempt to analyze the variations or explain them. In Quantz's study, referred to in the introduction, these variations were also noted, and an explanation proposed in terms of the position of the line. Quantz found an average eye-voice span of 7.4 words at the beginning of a line, 5.1 words in the middle, and 3.8 words at the end of a line. The results of the present study do not agree with those of Quantz. For the fifty-four subjects used, the width of the span at the beginning of the line is 12.7 letter-spaces, in the middle of the line 12.7, and at the end of the line 10.9. The only point of agreement is that the span is slightly narrower at the end of the line than in other positions. Since an analysis of the variations by position in the line does not afford an adequate explanation as to the reason for the variation, it must be concluded that there are other complicating factors. Accordingly, two factors which might complicate the situation were selected for further analysis. The fact that there is a large difference in the width of the span for the good and the poor readers suggested the possibility that quality of reading might be related in some way to the variation in width of span within a selection. Also, the fact that oral reading is modified according to the units of thought expressed suggested that position in the sentence might be a more potent factor than position in the line. Accordingly, a detailed analysis was made of the variation in the width of the eye-voice span by the position in the sentence for the good and poor readers separately, and then for all subjects taken together.

By referring to Plates III and IV, it will be seen that in the selection used, the eye-voice span was measured in positions at the beginning, middle, and end of the sentences. In the elementary-school selection, the positions where the span was measured were on the following words: (1) "kitten," (2) "wreath," (3) "paws," (4) "drew," (5) "box," (6) "last," (7) "head," (8) "wreath," (9) "couldn't." For the high-school selection the positions were on these words: (1) "two," (2) "scattered," (3) "read," (4) "few," (5) "obvious," (6) "complex," (7) "least," (8) "consciousness." In Tables IV and V and in Figures 4 and 5, the horizontal series of numbers refer to the positions in the selections in the same serial order as just given. By looking again at Plate III it will be found that for the elementary-school selection positions numbered 1 and 6 occurred at the beginning of sentences, positions 2, 4, 7, 8, and 9 fell within sentences, and positions 3 and 5 occurred at the end of sentences. For the high-school selections, Plate IV, positions 1 and 4 occurred at the beginning, positions 5, 6, and 7 within, and positions 2, 3, and 8 at the end of sentences.

Table IV gives the eye-voice span at each of the positions for the elementary-school subjects. It should be read as follows: Subject E1, a good reader from the second grade, had an eye-voice span of 18 letter-spaces at the first position, which was at the word "kitten" in the selection. At the second position, which was at the word "wreath," his span was 13 letter-spaces, etc. His average span was 11.8 letter-spaces, while the average variation among the positions was 2.5 letter-spaces. The second half of the table gives the data for the poor readers. The averages for each position are given for both good and poor readers. Figure 4 shows a comparison of these averages graphically, for both good and poor readers. The numbers on the horizontal axis refer to the number of the positions in the selection, while the letters *B*, *W*, and *E* are abbreviations for beginning, within, and end of a sentence. The figures on the vertical axis represent the width of the span in letter-spaces. The upper line is that of the good, and the lower line is that of the poor readers. Lines *b* and *d*, respectively, give the averages of the good and the poor readers for all positions.

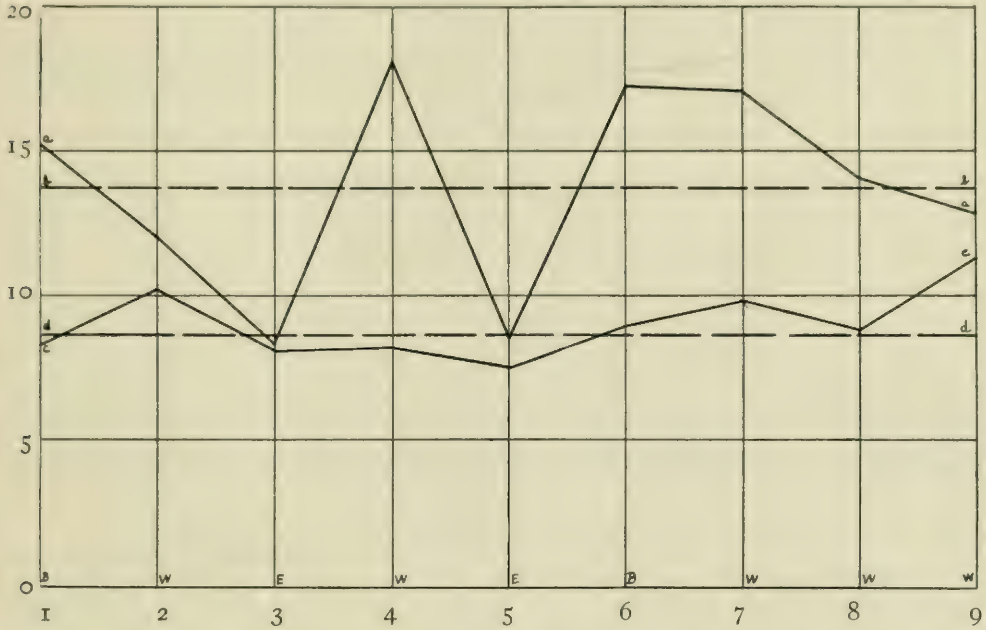


FIG. 4.—Average eye-voice span by position in sentence—elementary subjects. Position at beginning (B), within (W), and end (E) of sentence shown on horizontal axis. Width of eye-voice span shown on vertical axis.

The most noticeable deviations in the line *a*, for the good readers, occurred at positions numbers 3 and 5. These are the only positions occurring at the end of sentences. The shortening of the eye-voice span here is relatively very great, and is entirely too pronounced to be accidental. The good readers have evidently found that, for the sake of emphasis, a considerable pause must be made at the end of sentences. The time during the pause gives the eye ample opportunity to get ahead and consequently, on the last word before the pause, the eye-voice span is reduced. The relative shortening of the span on the last word of a sentence would therefore indicate an appreciation of the meaning and an attempt to convey it by expressing, through the pause, the fact that a unit of thought had been given. An examination of the record of the poor readers does not indicate any considerable variation in the length of the span at these points. Evidently the eye has travelled right along, the voice has ignored the ending of a unit of thought and has kept its regular distance behind the eye.

TABLE IV

AVERAGE EYE-VOICE SPAN BY POSITION IN SENTENCE—ELEMENTARY SUBJECTS

SUBJECT	GRADE	EYE-VOICE SPAN AT POSITIONS IN PARAGRAPH									AVERAGE	AVERAGE VARIATION
		1	2	3	4	5	6	7	8	9		
		Good Readers										
E1...........	II	18	13	11	.....	.....	.....	9	8	12	11.8	2.5
E2...........	II	6	5	.....	13	13	17	.....	6	12	10.3	3.9
E5...........	III	14	8	12	12	7	19	16	14	12	12.7	2.8
E6...........	III	15	15	10	20	.....	11	11	.....	14	13.7	2.6
E9...........	IV	17	13	6	.....	2	14	8	.....	18	11.1	5.0
E10..........	IV	19	8	2	28	10	25	20	21	.....	16.6	7.5
E13..........	V	20	20	11	23	21	17	26	.....	.....	19.7	3.3
E14..........	V	11	.....	9	11	.....	17	24	18	7	13.9	5.0
E17..........	VI	20	10	.....	21	7	17	12	18	14	14.9	4.1
E18..........	VI	10	5	2	19	5	.....	.....	13	8	8.9	4.4
E21..........	VII	.....	.....	8	16	3	13	20	.....	12	12.0	4.3
E22..........	VII	17	23	12	.....	.....	22	24	.....	20	19.7	3.4
Average		15.2	12.0	8.3	18.1	8.5	17.2	17.0	14.0	12.9	13.8	2.9
Average Variation ...		3.6	4.8	3.0	4.5	4.6	2.8	5.8	4.3	2.9	2.7	....
		Poor Readers										
E3...........	II	1	4	5	4	.....	3	.....	.....	.....	3.4	1.1
E4...........	II	13	.....	12	3	4	.....	.....	5	.....	7.4	4.1
E7...........	III	10	5	11	8	1	9	13	7	.....	8.0	2.8
E8...........	III	10	20	10	5	18	13	13	9	15	12.6	3.6
E11..........	IV	6	3	6	2	2	4	.....	.....	5	4.0	1.4
E12..........	IV	11	8	9	15	6	6	3	8	8	8.2	2.3
E15..........	V	9	.....	7	26	7	13	10	10	17	12.4	4.8
E16..........	V	11	6	2	.....	8	.....	5	6	11	7.0	2.6
E19..........	VI	8	.....	8	.....	.....	5	.....	11	.....	8.0	1.5
E20..........	VI	12	20	.....	.....	12	.....	13	15	.....	14.4	2.5
E23..........	VII	3	17	12	6	13	20	.....	8	12	11.4	4.2
E24..........	VII	5	.....	.....	6	4	8	12	9	.....	7.3	2.3
Average.............		8.2	10.3	8.2	8.3	7.5	9.0	9.8	8.8	11.3	8.7	0.9
Average Variation....		3.0	6.4	2.6	5.4	3.2	4.2	3.3	2.0	3.3	2.7	....

A second point of difference between the good and the poor readers is shown by Figure 4 at those positions falling at the beginning of sentences. Positions numbered 1 and 6 show the width of the eye-voice span at the beginning of two sentences. The line for the good readers shows a wider span than the average, at these points, while that of the poor readers varies from the general average by only a very small amount. This gives evidence that when a good reader begins the reading of a new thought, he allows the eye to proceed for a considerable distance before starting to read. This wide initial span gives him an intelligent grasp of the nature of the selection before beginning to read, and enables him to show a proper interpretation through his oral expression. The line for the poor readers shows that the initial span is no wider than the average. This would prevent the reader from obtaining a longer look ahead which is particularly helpful at the beginning of a sentence.

The line for the poor readers differs from that of the good in that it has only a small variation for all positions. For the poor reader, oral reading is evidently a monotonous process of passing over words without any great attempt to emphasize what is read. The good reader varies his span at different positions in the selection in order to bring about a better emphasis. This is shown in Table IV by the difference in the average variation of the averages for all positions. For the good readers the average variation of the averages is 2.9 letter-spaces, while for the poor readers the average variation is 0.9 letter-spaces. The study indicates, therefore, that for elementary-school pupils a variation in the width of the span for different positions is a characteristic of good reading more than of poor reading, and that for good readers the span is wider at the beginning of a sentence, a little narrower within a sentence, and much narrower at the end of a sentence. The poor readers show less variation and exhibit a tendency to commence reading as soon as the material is put before them, having a narrower span at the beginning than at those positions within the sentence. These data are very suggestive of a causal relationship between width of eye-voice span and the interpretation of meaning as exhibited by the treatment of a sentence as a unit of thought and the modification of the eye-voice span to fit such a unit.

The data showing the variation of the span by position in the sentence for the high-school subjects are given in Table V, and are expressed graphically in Figure 5. In general, the results are comparable with those of the elementary subjects. For the high-school selection, positions numbered 2, 3, and 8 occur at the end of sentences. The line for good readers shows a considerable drop in the eye-voice span at these points, while the drop for the poor readers is less marked. The positions at the beginning of sentences are numbers 1 and 4. Here both the good and the poor readers show a span which is wider than the average. The poor readers from the elementary school had a narrower span at the beginning of sentences. Evidently by the time pupils have reached the high school they have learned that a wider span at these positions is desirable and have inhibited the tendency to begin to read as soon as the selection is put before them. The poor readers from the high school look ahead enough to get an idea of the sentence before starting to read. This would be expected, since even a poor reader in the high school reads fairly well, while a poor reader in the elementary school is still in the process of learning to read. The line for the poor readers is more uniform than that of the good readers,

TABLE V

Average Eye-Voice Span by Position in Sentence—High-School Subjects

Subject	Grade	Eye-Voice Span at Positions in Paragraph								Average	Average Variation
		1	2	3	4	5	6	7	8		
		Good Readers									
H1	F	14	18	13	16	25	20	32	21	19.9	4.6
H2	F	14	15	13	12	12	15	15	18	14.3	1.5
H3	F	......	13	......	12	15	......	......	......	13.3	1.1
H7	So	......	......	21	16	......	6	11	6	12.0	5.2
H8	So	26	11	10	17	13	8	23	16	15.5	5.0
H9	So	23	14	11	......	......	......	......	......	16.0	4.7
H13	J	......	10	14	......	......	18	20	7	13.8	2.9
H14	J	22	17	10	......	26	......	15	16	17.7	4.2
H15	J	11	12	12	18	10	......	......	11	12.3	1.9
H19	Se	8	11	8	20	10	14	17	14	12.8	3.5
H20	Se	30	16	......	......	......	......	......	......	23.0	7.0
H21	Se	7	16	13	......	......	......	......	......	12.0	3.3
Average		17.2	13.9	12.5	15.9	15.9	13.5	19.0	13.6	15.2	1.8
Average Variation		7.1	2.3	2.3	2.2	5.5	4.3	5.1	4.1	2.7	....
		Poor Readers									
H4	F	9	10	11	......	......	......	......	......	10.0	0.7
H5	F	14	11	9	10	10	14	13	15	12.0	2.0
H6	F	16	7	19	14	12	13	......	6	12.4	3.5
H10	So	......	14	14	16	24	6	12	13	14.1	3.3
H11	So	11	8	8	13	8	15	8	6	9.6	2.5
H12	So	18	15	15	15	12	9	13	13	13.8	2.0
H16	J	11	12	2	10	8	10	9	6	8.5	2.4
H17	J	3	5	3	......	10	5	......	2	4.7	2.0
H18	J	......	12	11	......	......	......	......	......	11.5	0.5
H22	Se	15	9	22	18	9	15	9	14	13.9	3.6
H23	Se	13	9	10	10	9	13	11	11	10.8	1.3
H24	Se	17	11	9	......	......	10	......	15	12.4	2.9
Average		12.7	10.3	11.1	13.3	11.3	11.0	10.7	10.1	11.2	0.8
Average Variation		3.3	2.3	4.3	2.5	3.1	3.0	1.7	4.0	1.9	....

as was the case with the elementary subjects. Uniformity for the different positions, however, is evidently an indication that the sentence as a unit of thought is being ignored and that the eye and voice travel along with little regard for the separation of thought into different sentences.

A summary comparison of the eye-voice span at the different positions in the sentence is given in Table VI, for all subjects. Figure 6 presents these same results graphically. The summaries were compiled by grouping together all positions occurring at the beginning of sentences in one group, those occurring within the sentence in another, and those falling at the end of a sentence in a third group. The table shows the results of this grouping for the elementary, high-school, and adult subjects separately, and also for all fifty-four subjects together. In each table the results for the good and the poor readers are separated.

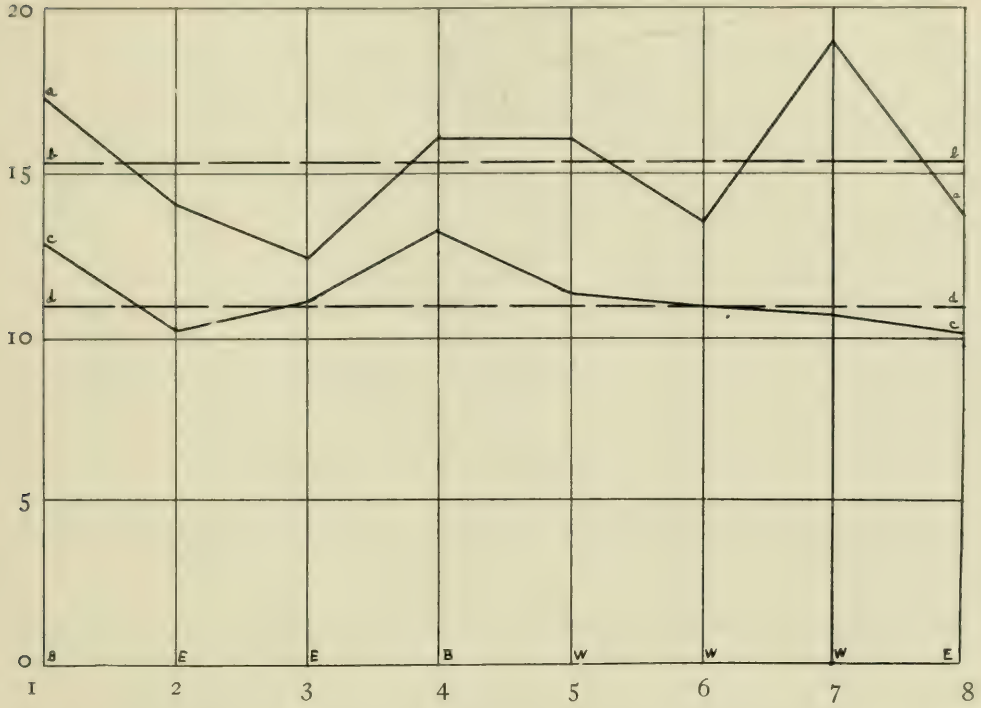


FIG. 5.—Average eye-voice span by position in sentence—high-school subjects

An examination of these data reveals two conspicuous facts: first, that the width of the eye-voice span is different at various positions in a sentence, and secondly, that the good and poor readers do not exhibit these differences in the same fashion.

The results of the investigation show that for the entire group of fifty-four subjects the eye-voice span is 15.9 letter-spaces at the beginning of a sentence, 13.4 spaces within the sentence, and 10.9 spaces at the end. The differences are even more marked in the group of twenty-seven good readers. For this group the average span at the beginning of a sentence is 18.7 letter-spaces, within the sentence 16.5 spaces, and at the end 11.9 spaces. The average span for the good readers at the beginning is greater than the average span within the sentence by 13 per cent and greater than the average at the end of the sentence by 57 per cent. For the poor readers the span at the beginning is greater than the span at the end in all three groups of subjects, and is greater than the span within the sentence for all but the elementary pupils. The evidence is quite conclusive, therefore, that the width of the eye-voice span varies according to the position in the sentence.

TABLE VI

Average Eye-Voice Span at the Beginning, Within, and at the End of Sentence—All Subjects

Subjects	Beginning of Sentence	Within Sentence	End of Sentence
Elementary subjects:			
Good readers	16.1	14.8	8.4
Poor readers	8.6	9.5	7.9
Good and poor	12.3	12.1	8.1
High-school subjects:			
Good readers	16.6	16.2	13.3
Poor readers	12.9	11.0	10.5
Good and poor	14.7	13.6	11.9
Adult subjects:			
Good readers	23.5	18.6	14.0
Poor readers	17.7	10.8	11.3
Good and poor	20.6	14.7	12.6
All subjects:			
Good readers	18.7	16.5	11.9
Poor readers	13.1	10.4	9.9
Good and poor	15.9	13.4	10.9

The characteristics of the variations of the eye-voice span at different positions in the sentence are not the same for good and poor readers. The curve for the good readers shows more regard for thought units, with the highest point always at the beginning and the lowest point always at the end of the sentence. The gross change in the width of the span for the different positions also is greater for the good readers.

The fact that the eye-voice span varies with the position in the sentence is of considerable significance. If the span varied only with

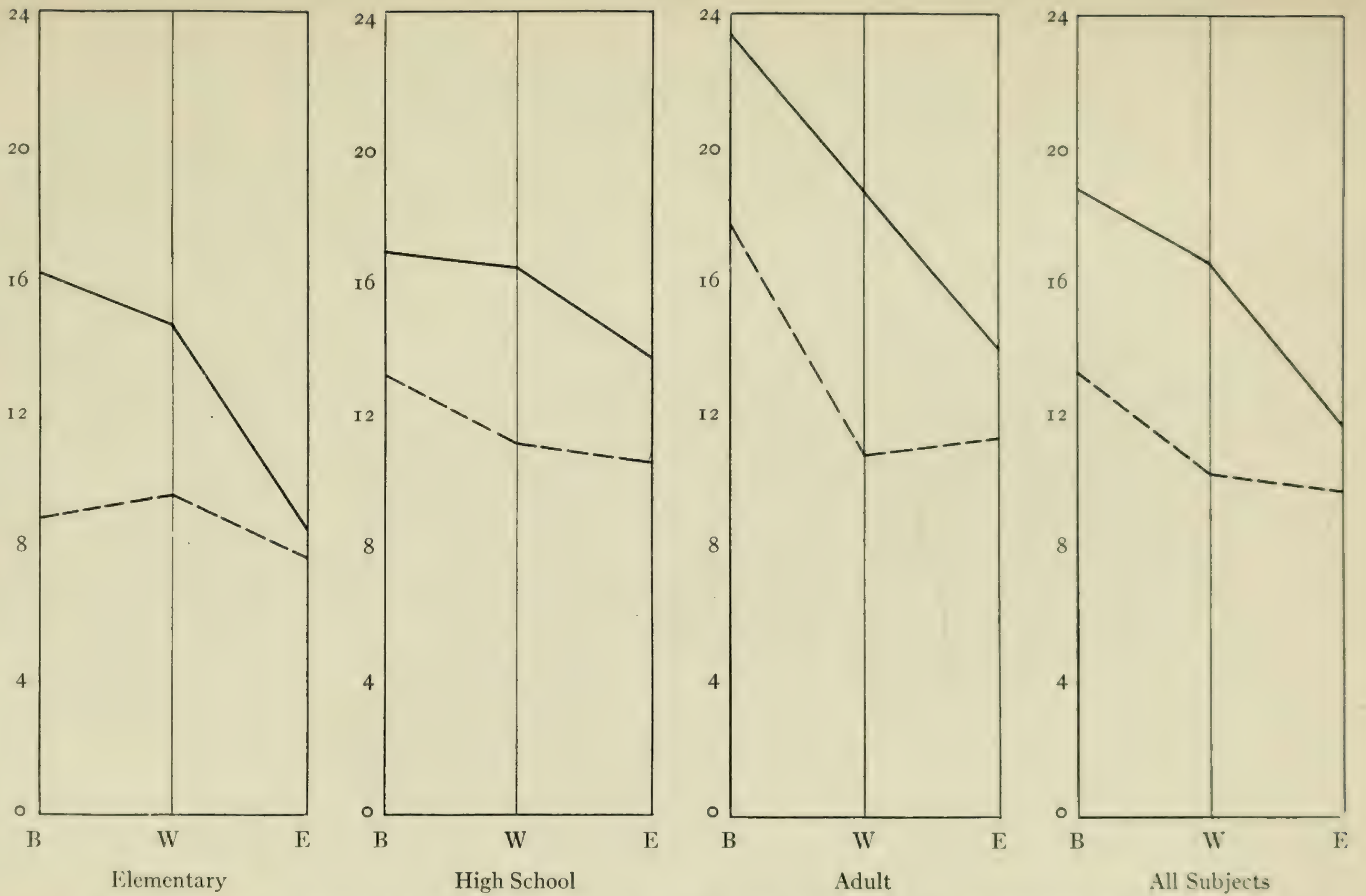


Fig. 6.—Average eye-voice span at the beginning (B), within (W), and at the end (E) of sentence—all subjects. Solid line represents good readers. Broken line represents poor readers.

the position in the line, as Quantz's study indicated, the determining factors would be entirely mechanical, and would be governed by the printed form of the selection. The control of the span, in that case, would be a matter of the mechanics of book construction, and would be independent of any teaching factor. But if the span varies with the position in the sentence, it is evident that the content of the meaning is recognized, and that the eye-voice span is determined by thought units rather than by printed line units. Position in the line may be a minor factor, as the results of this study showed a slightly narrower span at the end of a line, but the differences due to position in the sentence are much greater.

For all three classes of subjects, there is agreement among the good readers in that a wide eye-voice span occurs at the beginning of a sentence. The situation at the beginning of a sentence is different from that of any other position. After one has started to read, the meaning of the thought covered will carry him along to some extent, and will enable him to anticipate what is coming. At the beginning of a sentence there is no sequence of words to give one the cue to the content of the new thought. The only way to get this is to look ahead until the meaning of the sentence is partially recognized, and the kind of vocal expression needed is made clear. The good readers recognize this need for a wider span at the outset and inhibit the voice reaction until the eye has gained a considerable lead. The poor readers in the grades above the elementary school have also learned this, but evidently those in the elementary school are not mature enough in reading to recognize any special difficulty at the beginning of a sentence. Instead of making a relatively longer span, they react to the situation by a relatively shorter one. They begin to read as soon as they see the sentence, and have not learned to inhibit their reading until the eye has taken in a larger unit of meaning. This difficulty could be easily corrected by a little training in class which would teach the pupils to wait before starting to read until they get a larger unit of thought.

The evidence of all subjects agrees that there is a shorter span at the end of a sentence. The good readers have a relatively shorter span than the poor readers. The explanation of this shorter span goes back again to the fact that the sentence is the large unit of meaning. When the eye reaches the end of this unit it modifies its movements according to the meaning recognized and the voice catches up before beginning the new thought. In order that the voice shall express the thought clearly, a pause is necessary at the end of the sentence. This pause gives the eye ample opportunity for a large eye-voice span before it is time to commence the next sentence. A poor reader pays less attention to the sentence as a unit of meaning. This is especially true of younger children who are very immature readers. For them the whole process is a more or less monotonous repetition of words as they are encountered. The eye moves along at a regular rate and the voice follows. The end of a sentence creates no special disturbance for it is passed over with little attention. Consequently there is little change in the eye-voice span. The curve for the poor readers from the elementary school would seem to indicate that some such situation exists. There is little variation in the width of the span for any position in the sentence. If the variation in eye-voice span at the beginning and the end of a sentence makes possible a greater emphasis on meaning, the lack of such a variation may account for the fact that the subjects showing such lack are classed as poor readers.

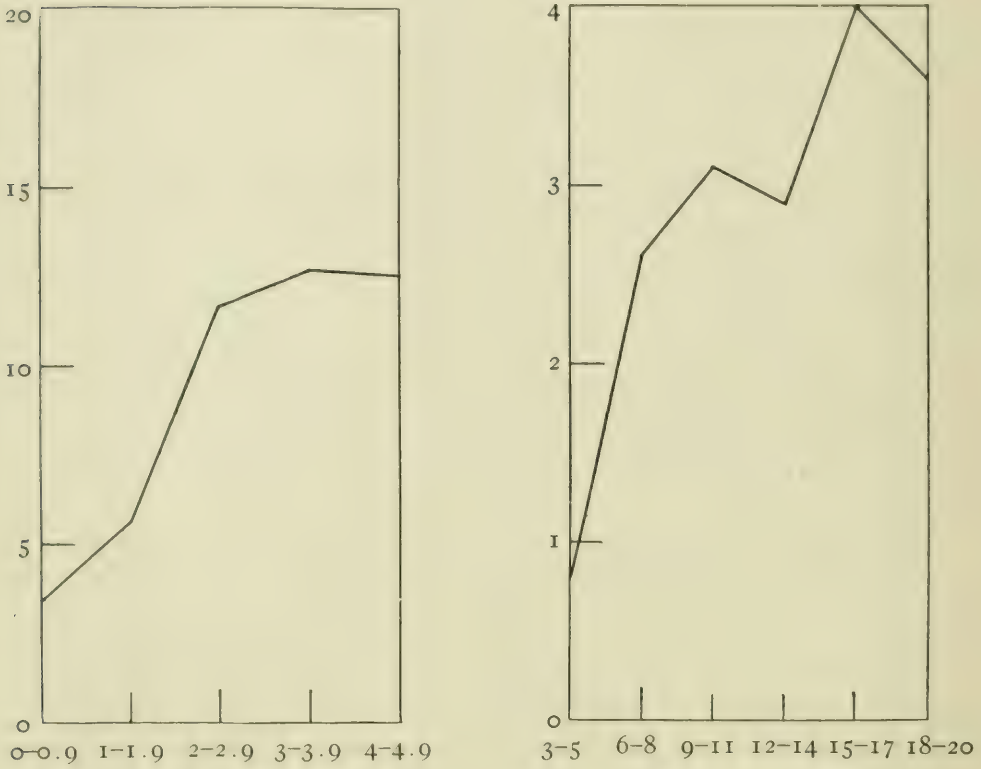
Relation of eye-voice span to reading rate.—In the previous sections of this chapter it has been shown that a wide eye-voice span correlates with good reading and also with certain positions in the sentence. Since numerous studies have shown a correlation between quality and rate of reading, it would be of interest to find if the eye-voice span is related to rate in the same way. Accordingly, a study was made of the relation of eye-voice span to reading rate for the subjects in the elementary school, the high school, and for the entire group of subjects taken together. The reading rate of each subject was taken with the same material at the time of the experiment. Comparisons are given both in terms of rate per second and the average eye-voice span. The data for the elementary school are given in Table VII, for the high school in Table VIII, and for all subjects taken together in Table IX. The figures showing the same data are numbered to correspond with the tables.

Table VII gives the data for the elementary subjects and should be read as follows: Using rate per second as a base, it was found that one subject had a rate falling between 0 and 0.9 words per second and an eye-voice span of 3.4 letter-spaces, two subjects had rates falling between 1 and 1.9 words per second and an average eye-voice span of 5.7 letter-spaces, nine subjects had rates falling between 2 and 2.9 words per second and an average span of 11.6 spaces, etc. The second part of the table gives the data based upon eye-voice span instead of rate, and should be read: Two subjects had average spans of between 3 and 5 letter-spaces and an average rate of 0.8 words per second, six

TABLE VII

RELATION OF EYE-VOICE SPAN TO READING RATE—ELEMENTARY SUBJECTS

Number of Subjects	Rate of Words per Second	Average Eye-Voice Span
	By Rate	
1	0–0.9	3.4
2	1–1.9	5.7
9	2–2.9	11.6
9	3–3.9	12.6
3	4–4.9	12.5
	By Eye-Voice Span	
2	0.8	3–5
6	2.6	6–8
5	3.1	9–11
8	2.9	12–14
1	4.0	15–17
2	3.6	18–20



By rate

By eye-voice span

FIG. 7.—Relation of eye-voice span to reading rate—elementary subjects. By rate: words per second shown on horizontal axis; average eye-voice span on vertical axis. By eye-voice span: words per second shown on vertical axis; average eye-voice span on horizontal axis.

subjects had spans falling between 6 and 8 letter-spaces and an average rate of 2.6 words per second, etc. The tables and figures for the elementary subjects show a high positive correlation between rapid reading and a wide eye-voice span.

The comparisons for the high-school pupils are given in Table VIII and Figure 8. Here again a positive correlation is shown between rapid reading and a wide span. The reading rates of the high-school subjects are more nearly uniform than those of the elementary school, all falling within the interval between 2 and 4.9 words per second. The second figure showing the relation between rate and eye-voice span, by using the average span for a base, exhibits a very great variation in the average eye-voice spans. The extremes on both ends of the curve are represented by only a single subject and because of this small number of cases the line for the extremes is dotted instead of solid. The curves are not so steep as those for the elementary school because the increase in rate is less during the high-school years.

Table IX and Figure 9 give the results for the entire group of fifty-four subjects. The evidence here is perfectly clear that a wide eye-voice span is a characteristic of rapid readers for subjects of all grades of advancement from the second grade of the elementary school to the college.

It has been shown in the first part of this chapter that some good readers in the fifth grade have an eye-voice span as wide as many high-school pupils. If it is possible to develop a wide eye-voice span in the first four years of school it would be an aid not only to quality of reading but also to rate. A training experiment, with this aim in view, for pupils in the second, third, and fourth grades, would furnish an interesting problem for further research.

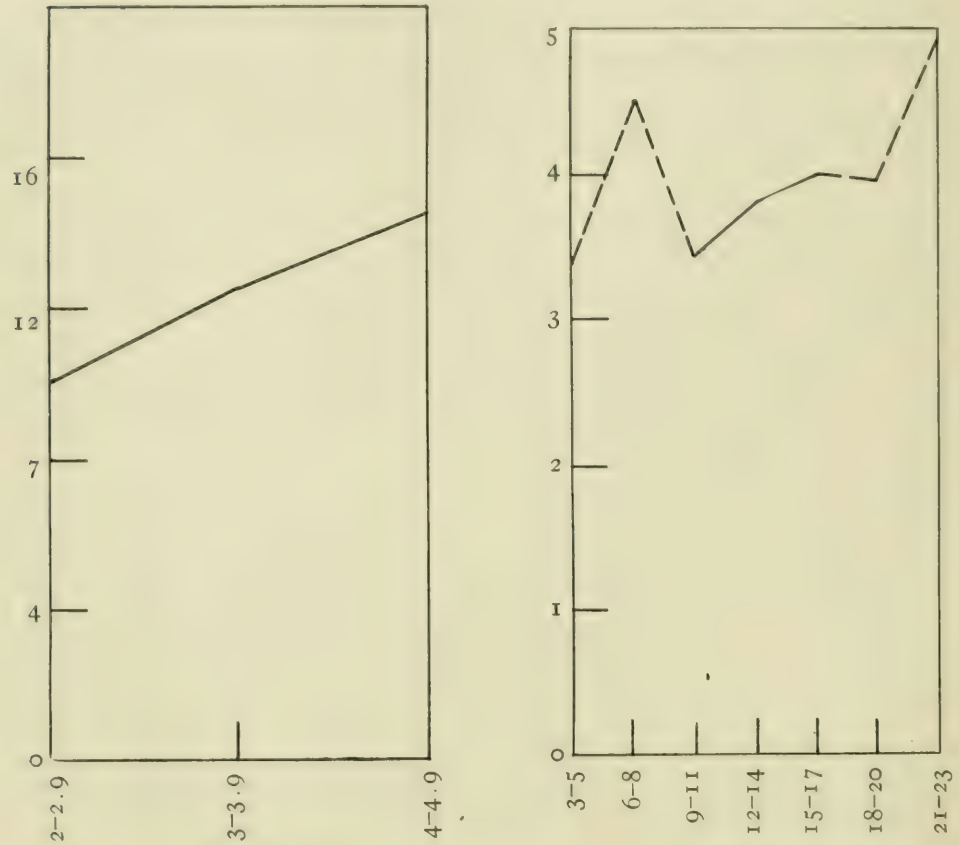
The fact that a wide eye-voice span provides a larger unit of reading material which can be covered by the eye before the voice reaches it makes possible a more rapid oral presentation of the unit without failing to give each word its proper emphasis. The total time for reading such a unit may be reduced by rapid reading, without changing the relative amount of time given to its parts for the sake of proper expression. This cannot be done, however, unless the eye-voice span is wide enough to provide a large unit of meaning. Rapid reading without a correspondingly wide eye-voice span would be a monotonous or "sing-song" pronunciation of words.

Relation of eye-voice span to number of fixations.—An examination of plates giving the records of eye-movement will show that the number

TABLE VIII

RELATION OF EYE-VOICE SPAN TO READING RATE—HIGH-SCHOOL SUBJECTS

Number of Subjects	Rate in Words per Second	Average Eye-Voice Span
	By Rate	
1	2–2.9	10.0
16	3–3.9	12.6
7	4–4.9	14.6
	By Eye-Voice Span	
1	3.3	3–5
1	4.5	6–8
4	3.4	9–11
14	3.8	12–14
2	4.0	15–17
1	3.9	18–20
1	4.8	21–23



By rate

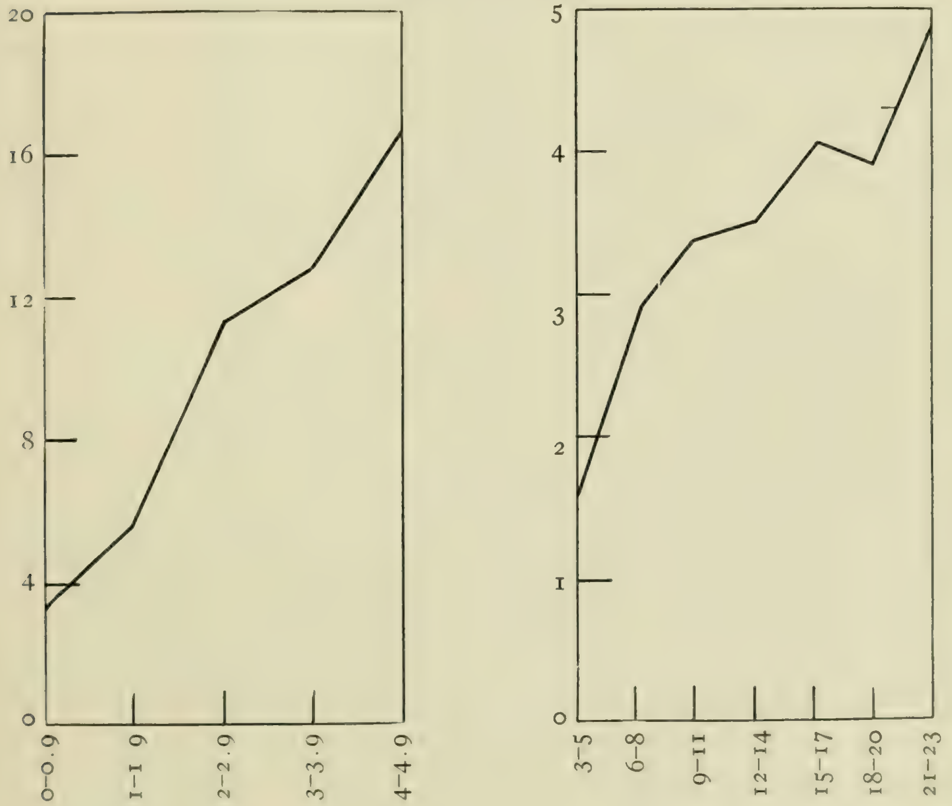
By eye-voice span

FIG. 8.—Relation of eye-voice span to reading rate—high-school subjects. By rate: words per second shown on horizontal axis; average eye-voice span on vertical axis. By eye-voice span: words per second shown on vertical axis; average eye-voice span on horizontal axis.

TABLE IX

RELATION OF EYE-VOICE SPAN TO READING RATE—ALL SUBJECTS

Number of Subjects	Rate of Words per Second	Average Eye-Voice Span
	By Rate	
1	0–0.9	3.4
2	1–1.9	5.7
10	2–2.9	11.3
29	3–3.9	12.7
12	4–4.9	16.5
	By Eye-Voice Span	
3	1.6	3–5
7	2.9	6–8
10	3.3	9–11
24	3.5	12–14
4	4.1	15–17
5	3.8	18–20
1	4.8	21–23



By rate

By eye-voice span

FIG. 9.—Relation of eye-voice span to reading rate—all subjects. By rate: words per second shown on horizontal axis; average eye-voice span on vertical axis. By eye-voice span: words per second shown on vertical axis; average eye-voice span on horizontal axis.

of fixation pauses per line varies from subject to subject. Table X gives the relation of the width of the eye-voice span to the number of fixations per line, both by eye-voice span and by number of fixations. This table using eye-voice span as a base should be read as follows: Three subjects had an average eye-voice span of from 3 to 5 letter-spaces with an average of 13 fixations per line; seven subjects had an average span of 6 to 8 letter-spaces with an average of 12 fixations per line, etc. The second table is read in the same manner using the average number of fixations per line as a base. Figure 10 gives a graphic representation of the same data. The dotted lines at the right of each curve indicate that a limited number of subjects occurs at the extremes, and that the variation in the general form of the curve is not a characteristic of the subjects as a group. In each case the break in the general form of the curve is caused by a single subject.

TABLE X

Relation of Eye-Voice Span to Average Number of Fixations per Line—All Subjects*

Number of Subjects	Average Eye-Voice Span	Number of Fixations
	By Eye-Voice Span	
3	3–5	13.0
7	6–8	12.0
10	9–11	9.3
24	12–14	9.0
4	15–17	7.9
5	18–20	7.5
1	21–23	9.9
	By Number of Fixations	
13	15.1	6–7
26	12.8	8–9
10	11.5	10–11
2	7.3	12–13
1	12.5	14–15
2	5.7	16–up

* Lines 5 and 6 in high-school selection omitted.

The curves indicate a negative correlation between the width of the eye-voice span and the number of fixations per line. As the size of the span increases the number of fixations decreases. All of the previous studies of eye-movement have shown that a small number of fixations per line is a characteristic of good readers. Consequently it would be expected that the kind of correlation shown by Figure 10 would exist. An experiment attempting to reduce the number of fixations per line by training for a wider eye-voice span might give some interesting results.

Relation of eye-voice span to regressive movements.—One of the characteristic features of both oral and silent reading is that the eye fixations do not progress continuously across a line, but that their progress is interrupted from time to time by backward or regressive movements. The number and length of these regressive movements varies with different subjects, but they are found on the records of all readers. The backward movement of the eye is evidence that the reader has not grasped the entire meaning of the words which the eye has passed over and that a second fixation is needed.

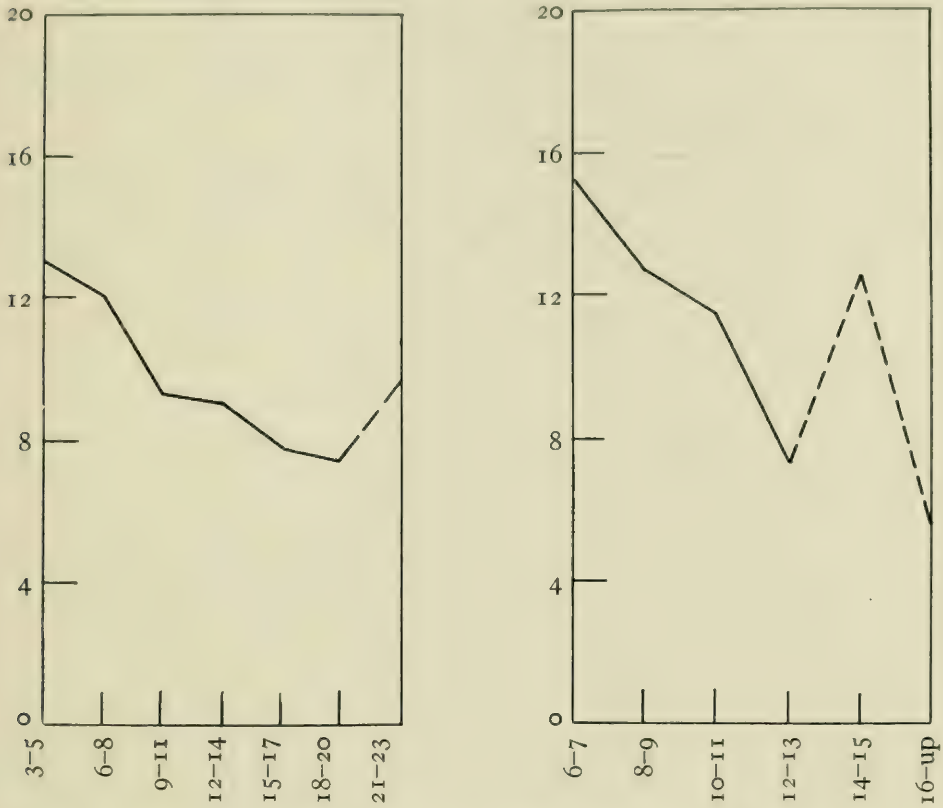


FIG. 10.—Relation of eye-voice span to average number of fixations per line—all subjects. By eye-voice span: average eye-voice span shown on horizontal axis; average number fixations per line on vertical axis. By number of fixations: average number of fixations per line on horizontal axis; average eye-voice span on vertical axis.

It would be expected that subjects having a wide eye-voice span would be able to get the meaning of a sentence with fewer regressive movements than those keeping the eye and voice close together. Accordingly, a study was made of the relation of the eye-voice span to the number of regressive movements per line. The results appear in Table XI. No consistent relationship is shown by this table, except that the subjects having the largest number of regressive movements have a somewhat narrower span.

The fact that no correlation was made apparent by this method of comparison indicates that either none existed or that complicating factors were off-setting each other. If the plates reproduced in the first part of this chapter are studied, it will be seen that there are different kinds of regressive movements.

Plates VI and VII will serve to illustrate these different types of regressive movements. Plate VI shows that this reader makes a great many regressive movements, averaging 5.8 per line. If the serial order of the fixations is followed it will be observed that there is a continual forward and backward movement all along the line. Of the first 10 fixations in the first line 5 are preceded by regressive movements. Eleven fixations with 5 regressive movements are required to recognize the first three words. The cause of such regressive movements is not that the eye passes over words too rapidly and returns to observe some part which has been overlooked, but a general confusion and inability to recognize the words after the eye has seen them. This kind of regressive movement is the mark of very poor reading ability.

TABLE XI

RELATION OF EYE-VOICE SPAN TO NUMBER OF REGRESSIVE MOVEMENTS PER LINE

Number of Subjects	Average Number Regressive Movements per Line	Average Eye-Voice Span
7	0–0.9	12.9
29	1–1.9	12.8
10	2–2.9	13.2
6	3–3.9	10.0
0	4–4.9	....
2	5–5.9	5.7

Plate VII shows the record of a subject who also has a large number of regressive movements, averaging 3.1 per line. It is plainly evident, however, that these backward movements are of an entirely different type from those in Plate VI. In the first line the movement from fixation 5 to fixation 6 is in the backward direction. The reason for this appears to be that the eye has attempted too much in trying to finish the line by one fixation after number 4. It risked a long jump, failed to grasp the entire meaning, and moved back to pick up the part missed. Good reading demands that the jump from fixation to fixation be as long as possible. This reader attempts very long eye-movements all through the selection. Occasionally he fails to grasp as much as the eye covers and the eye must make a regressive movement to recover the words missed. In such a situation, a regressive movement is a characteristic of good rather than of poor reading. It is just the opposite of the practice of the reader shown in Plate VI. For him, the regressive movements were not the result of attempting too long an eye-movement, but were caused by the necessity of seeing every detail of a word before being able to recognize it. The important facts about regressive movements are neither their number nor their length, but are rather concerned with the eye-movements which precede them. A study of regressive movements must, therefore, be based upon the preceding eye-movements. Subject E6, shown in Plate VII, made 16 regressive movements. Of these, nine followed eye-movements of more than ordinary length, being in terms of letter-spaces: 9–9–11–12–13–15–16–16 and 20. Backward eye-movements were necessary for this subject because the eye had attempted to cover too long a distance in the preceding movement. But the effort to cover a long distance is certainly desirable and is characteristic of a mature reader. Compare the record of this reader with that of Subject E3, shown in Plate VI. This subject made 29 regressive movements, and the ten longest eye-movements preceding them are as follows: 8–6–5–5–4–4–4–4–4 and 3. It cannot be said that this subject needed to make backward movements because he attempted too much. His regressive movements were caused by an entirely different reason, and they must be classified as a different type from those of Subject E6.

Such facts as the above make it clear that regressive movements cannot be treated as if they were all of the same nature. They must be analyzed into their various types and each type treated separately. For the purpose of this study, those regressive movements are most important which are caused by the eye attempting to cover too much and failing in the attempt. It would be expected that a reader having a wide eye-voice span would make a larger proportion of this type of regressive movements than of any other. Accordingly a comparison was made to see what relation existed.

The records of each of the subjects were studied and the length of each eye-movement-just-preceding-a-regressive-movement was tabulated. It was found that, for the elementary subjects, the good readers had an average length of this eye-movement of 8.6 letter-spaces as compared with 5.7 spaces for the poor readers. This led to a further analysis of the material. A tabulation of the average length of the eye-movements-just-preceding-regressive-movements for all fifty-four subjects showed that the median length of these movements was 7 letter-spaces and that the upper quartile included all averages greater than 8 letter-spaces. Since this analysis is concerned only with regressive movements which are caused by the eye attempting too great a movement, the eye-movements falling in this upper quartile, those 9 or more letter-spaces in length, were selected for study. Accordingly, a tabulation was made of the percentage of those eye-movements which were 9 or more letter-spaces in length. Since all of these eye-movements were among the upper 25 per cent of the total in length, the regressive movements following them can be attributed to an attempt to make too long a movement of the eye. A comparison can therefore be made showing the relation of eye-voice span to this particular type of regressive movement.

This comparison is shown by Table XII and Figure 11. In this table the first column gives the number of subjects in each division. The second column gives the percentage of eye-movements-just-preceding-regressive-movements 9 or more letter-spaces in length. The third column gives the average eye-voice span for those subjects corresponding to each percentage. The table should be read as follows: There are 16 subjects having from 0 to 9 per cent of their eye-movements-just-preceding-regressive-movements 9 or more letter-spaces in length, and their average eye-voice span is 10.5 letter-spaces; there are 3 subjects having from 10 to 19 per cent of their eye-movements-just-preceding-regressive-movements 9 or more letter-spaces in length, and their average eye-voice span is 7.9 letter-spaces. Figure 11 shows the data graphically. The dotted part at the upper end of the curve signifies that only a limited number of subjects, one for each position, is represented. The dotted line at the beginning of the curve signifies that the first figure is a complex and needs further analysis. Some of the subjects having from 0 to 9 per cent of their eye-movements-just-preceding-regressive-movements 9 or more letter-spaces in length should not properly be used. There are five good readers having 0 per cent of these long eye-movements because they have only a few regressive movements of any kind. These five subjects have an average of less than one regressive movement per line. With this allowance for the first number, the curve is a true representation of the relation of the eye-voice span to the regressive movements caused by too long an eye-movement-just-preceding-a-regressive-movement.

TABLE XII

Relation of Eye-Voice Span to Eye-Movements-Just-Preceding-Regressive-Movements—All Subjects

Number of Subjects	Percentage of Regressive Movements Preceded by Very Long Eye-Movements	Average Eye-Voice Span
16	0–9	10.5
3	10–19	7.9
9	20–29	10.7
5	30–39	11.5
8	40–49	14.9
6	50–59	16.6
5	60–69	16.0
1	70–79	13.7
1	80–89	13.9

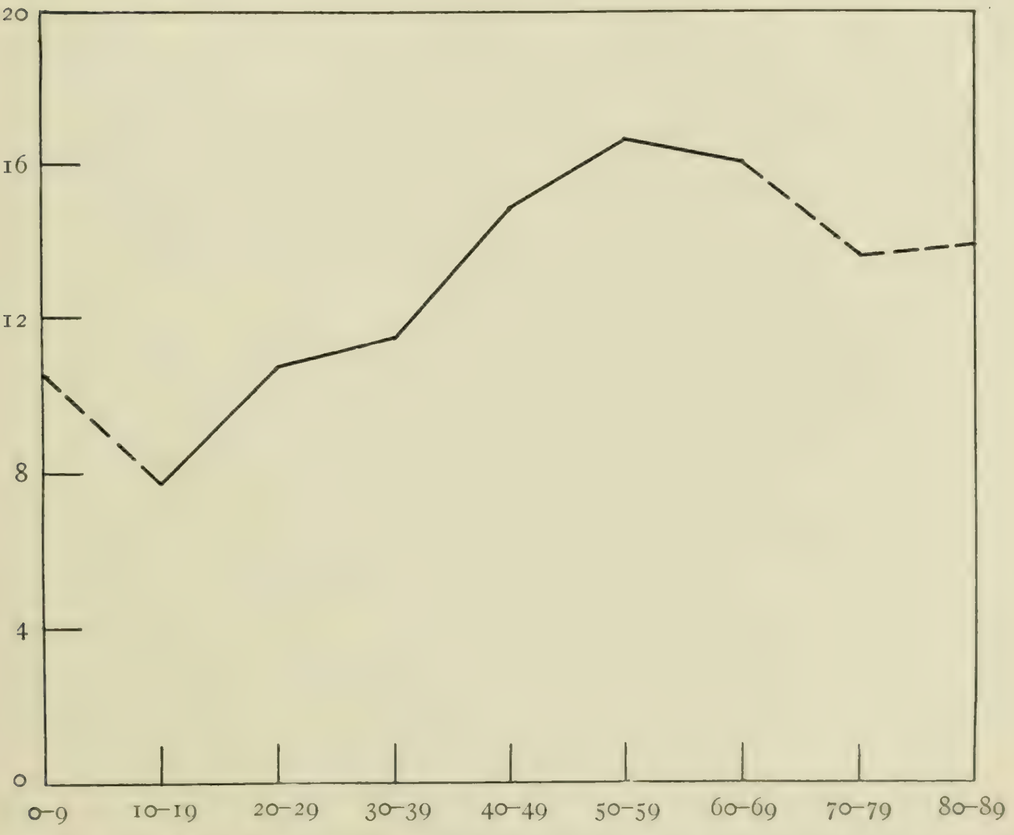


Fig. 11.—Relation of eye-voice span to eye-movements-just-preceding-regressive-movements—all subjects. Average eye-voice span on vertical axis. Percentage of very long eye-movements-just-preceding-regressive-movements on horizontal axis.

This correlation makes it clear that this type of regressive movement is an indication of mature reading habits, and that it is a characteristic of good readers to risk a long eye-movement. It also makes it clear that the regressive movements of subjects having a wide eye-voice span are caused in a greater percentage of cases by attempting a long eye-movement, while those regressive movements of subjects having a narrow eye-voice span are caused more often by confusion in reading and other unanalyzed difficulties. In the first case the regressive movements are sacrifices made in an effort to use a longer eye-movement; in the second case they are in most instances merely attempts to correct difficulties which should never exist and which are not common among mature readers.

SUMMARY OF ANALYSIS OF EYE-VOICE SPAN

The relations of the eye-voice span to other factors of reading as described in this chapter may be summarized as follows:

1. There is a positive correlation between a wide eye-voice span and mature reading. The average span for good readers is greater than that of poor readers in every school grade.

2. The development of the eye-voice span through the school period does not show a consistent increase from grade to grade, but is very irregular. The average span for the high school is greater than that of the elementary school. The average span of the adult subjects is greater than that of those from the high school. But some good readers from the elementary school have a span greater than most of the high-school subjects.

3. The width of the eye-voice span shows little correlation with position in the line, except that the span at the end of a line is slightly narrower. A high correlation is shown between eye-voice span and position in the sentence. The average width of the span at the beginning of a sentence is greater than at the end of the sentence by 46 per cent, while the average within the sentence is greater than that at the end by 23 per cent. These percentages are for all fifty-four subjects including both good and poor readers.

4. A comparison of reading rate with eye-voice span shows that rate of reading and width of eye-voice span increase together. There is a high positive correlation between these two factors of reading.

5. A negative correlation exists between the eye-voice span and the number of fixations per line. As the span increases in width the number of fixations per line decreases.

6. Little correlation is evident between eye-voice span and the number of regressive movements per line. However if the regressive movements are analyzed into their various types, a positive correlation is shown between eye-voice span and that type of regressive movements caused by too long a forward sweep of the eye. As the width of the eye-voice span increases, the percentage of regressive movements caused by this habit of attempting a long forward movement increases. This type of regressive movements must be considered as a characteristic of mature reading.

This study shows that a wide eye-voice span occurs in common with good quality of reading, rapid rate of reading, a small number of fixations per line, and a certain type of regressive movements. All of these qualities may be described as characteristic of a mature reader. It is also evident from the data shown that a narrow eye-voice span occurs with a poor quality of reading, a slow rate, a large number of fixations per line, and a larger percentage of a type of regressive movements which are not characteristic of good reading. These qualities may be considered as characteristic of persons whose reading habits are immature.

The results of the preceding analysis make it very clear that the development of a wide eye-voice span is a significant element in oral reading. As will be shown later, in silent reading a similar meaning-recognition span exists which appears to be closely related, in its development, to the eye-voice span. Since the width of eye-voice span is a factor of mature reading it should receive very definite attention in methods of teaching reading. However, it is difficult to find any allusion to the subject in any of the method texts or manuals. No evidence can be found that elementary teachers in the public schools give any attention to the problem in their teaching, probably because no specific methods are available for dealing with it. Expert teachers of primary reading have worked out a few devices, based upon rapid scanning of phrases and the use of familiar material, which they use in their own classes, but they say that there is nothing available in the literature of reading methods which deals specifically with training for a wider eye-voice span. It is not the function of this investigation to devise methods of teaching, but it is in place to state that here is a significant factor of reading which is in need of specific training methods. The problem is to devise methods which will develop a habit of pushing the eye farther ahead of the voice in order that there may be an interpretation of meaning in larger units.

CHAPTER III

CONTINUOUS RELATIONSHIP OF EYE AND VOICE

In the preceding chapter an analysis was made of the characteristics of the eye-voice span at certain positions in the selections used. It is desirable to know the characteristics of the span at every word and every fixation rather than simply at intervals through a paragraph. Such an analysis is of interest for two reasons: first, it shows the continuous relationship of the eye and voice and the manner in which the variations in the width of the span take place, and secondly, it explains in a measure, the behavior of the eye during the very long fixation pauses which occasionally occur. Such an analysis as just described will be presented in this chapter.

METHOD

It has been explained that a dictaphone record was taken of the oral reading of each subject at the time the eye-movements were photographed. By means of the electric bell and reversed camera shutter, described in the introduction, it was possible to synchronize the voice with the eye-movement record on the film. By this means the position of the eye and voice at the same instant could be determined at intervals through the reading. These locations were shown in the plates in the preceding chapter. By using these locations as basic points, the relation of the eye and voice at any succeeding point could be determined by measuring equal units of time from these bases. The installation of a special spring motor in the dictaphone, which runs with uniform speed from revolution to revolution, insures accuracy for the voice measurement. The measurement of time for the eye is accomplished by adding together the duration of the fixations, while for the voice it is measured by taking the time with a stop-watch from the basic points to each of the following words as they are pronounced on the dictaphone record. This method will be made clear in the next paragraph by reference to a diagram in one of the plates.

Plate XXI shows the record of Subject H1, a good reader from the freshman class. The selection has been duplicated in parallel lines in order to show the eye-voice relationship more clearly. The upper line of the pairs may be called the eye-line, and shows the position and duration of eye-fixations in the same manner as in all of the preceding plates. The lower line of the pairs may be called the voice-line. The diagonal lines connect the positions of the eye and voice for every fixation.

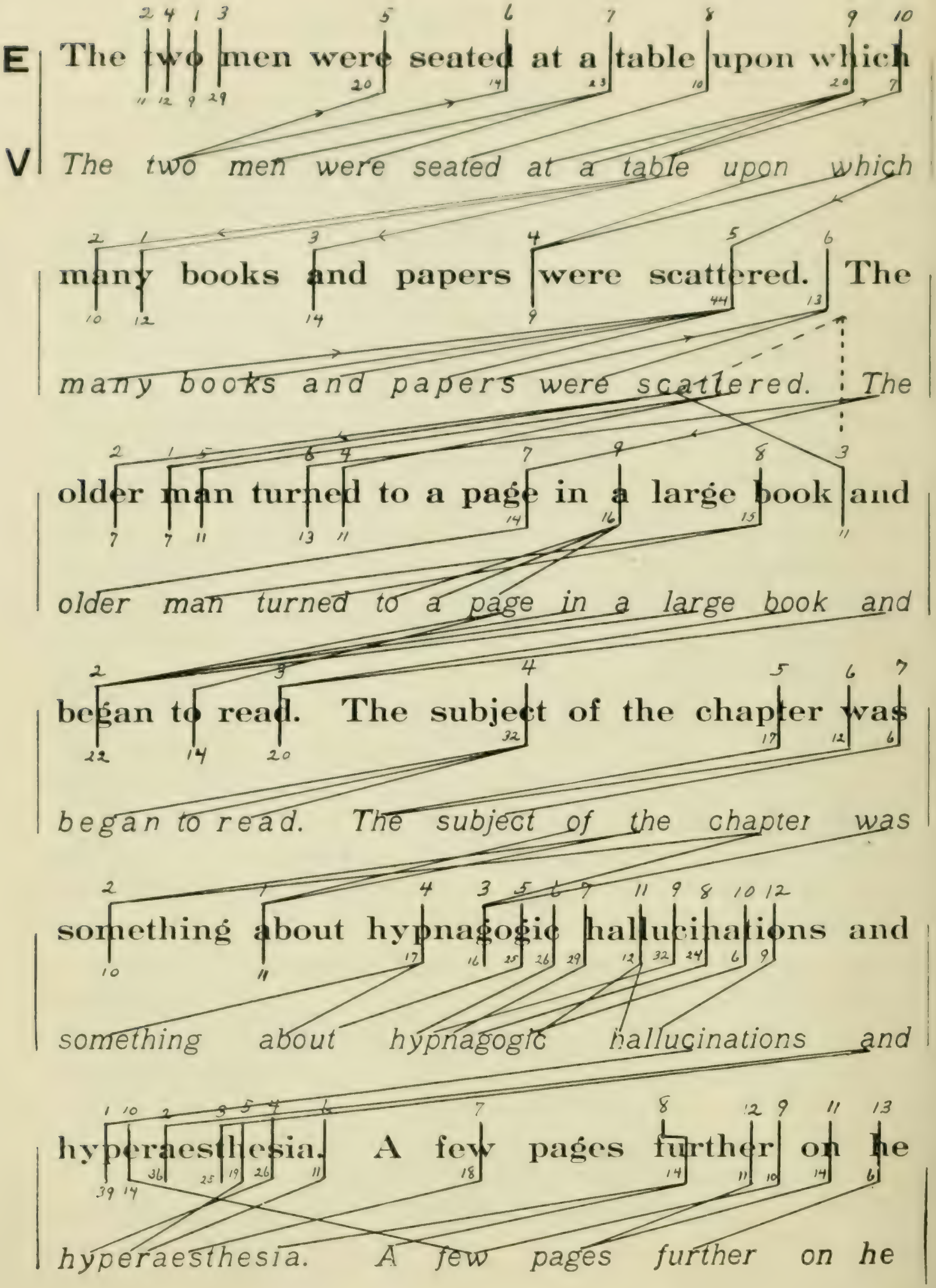
In the record shown in Plate XXI, the positions of the eye and voice were synchronized first as the voice was pronouncing the word "two" in line 1. As the voice began to pronounce "two" the eye was fixated on the last letter of the word "were," which is the fifth fixation in the line. These two points may therefore be taken as a base of measurement for the determination of the relative positions of the eye and voice at the succeeding words and fixations. It will be observed by reference to the plate, that 34 (20+14) fiftieths of a second elapsed during fixations 5 and 6. The time on the stop-watch showed that at a point 34 fiftieths of a second after beginning to pronounce "two," the voice had not begun to pronounce the next word, indicating that fixations 5 and 6 were both made during the time used by the voice in reading the word "two." From fixation 5 to the end of fixation 7 a time of 57 (20+14+23) fiftieths of a second elapsed. The record from the stop-watch and the dictaphone showed that during the interval from 34 fiftieths of a second to 57 fiftieths, the voice had pronounced the words "men" and "were." By a continuation of this form of analysis, the relative positions of the eye and voice were located for every word and every fixation.

The accuracy of the dictaphone time record was made possible by the installation of a special motor which runs with constant speed from revolution to revolution. Only a limited number of subjects were given this form of analysis because of the fact that the method is exceedingly tedious and time-consuming, and also because such a form of analysis can only be applied to film and dictaphone records which are perfect in every detail. The records of nine subjects are shown in Plates XXI–XXIX.

EXPLANATION OF TYPICAL PLATES

The plates may be interpreted either with reference to the eye-line or the voice-line. Arrow heads are inserted for the first few lines of Plate XXI indicating the direction of the eye fixations from the location of the voice. This plate should be read by following the voice-line. While the voice was pronouncing the word "two" the eye was covering fixations 5 and 6, as shown by following the diagonal lines leading from "two." While the voice was pronouncing "men" the eye was located

PLATE XXI


E
V
2 4 1 3 5 6 7 8 9 10
The two men were seated at a table upon which
11 12 9 29 20 14 23 10 20 7
The two men were seated at a table upon which
2 1 3 4 5 6
many books and papers were scattered. The
10 12 14 9 44 13
many books and papers were scattered. The
2 1 5 6 4 7 9 8 3
older man turned to a page in a large book and
7 7 11 13 11 14 16 15 11
older man turned to a page in a large book and
2 3 4 5 6 7
began to read. The subject of the chapter was
22 14 20 32 17 12 6
began to read. The subject of the chapter was
2 1 4 3 5 6 7 11 9 8 10 12
something about hypnagogic hallucinations and
10 11 17 16 25 26 29 12 32 24 6 9
something about hypnagogic hallucinations and
1 10 2 3 5 4 6 7 8 12 9 11 13
hyperaesthesia. A few pages further on he
39 14 36 25 19 26 11 18 14 11 10 14 6
hyperaesthesia. A few pages further on he

Continuous eye-voice relationship, Subject H1

PLATE XXI*a*

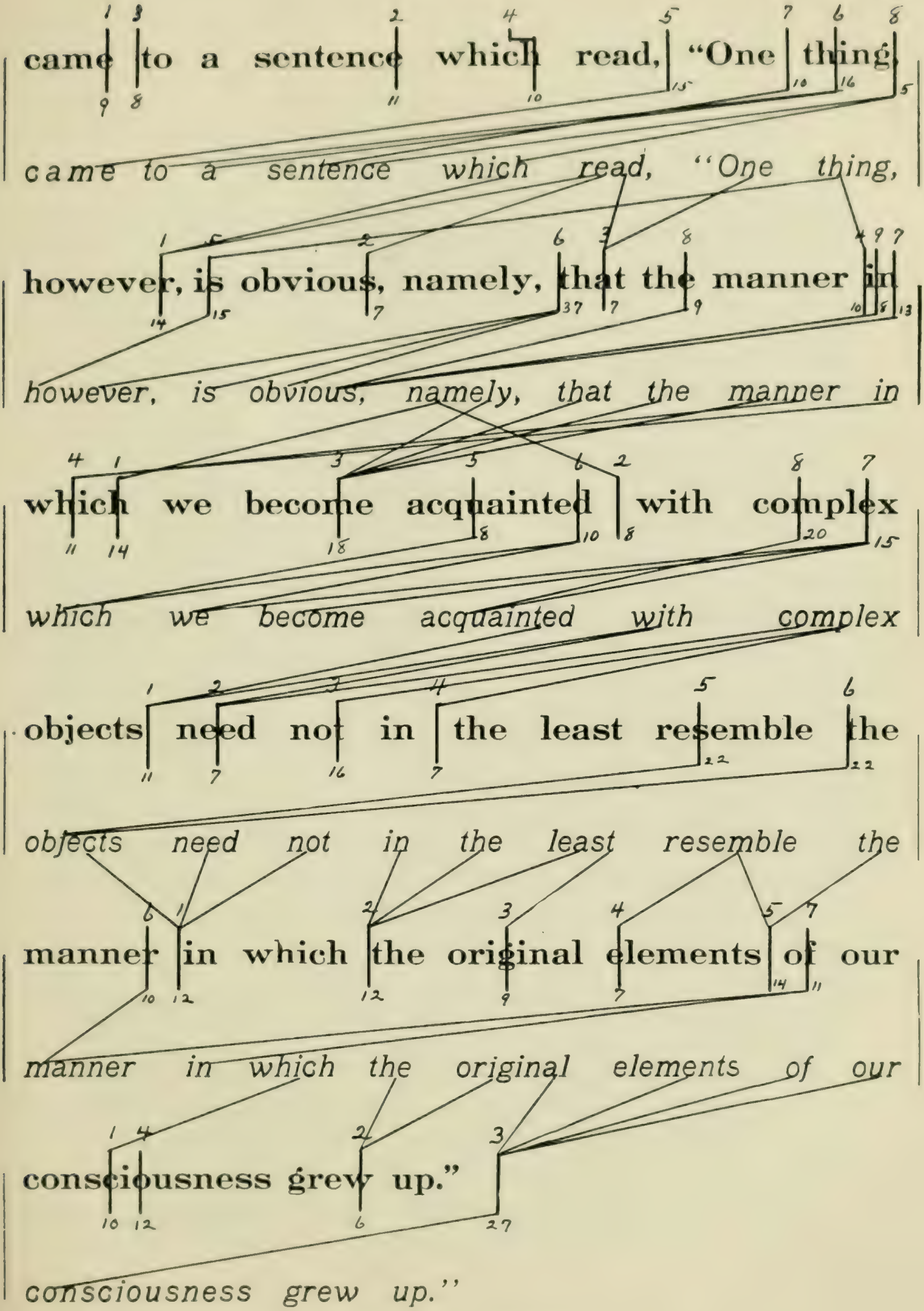

came to a sentence which read, "One thing,
came to a sentence which read, "One thing,
however, is obvious, namely, that the manner in
however, is obvious, namely, that the manner in
which we become acquainted with complex
which we become acquainted with complex
objects need not in the least resemble the
objects need not in the least resemble the
manner in which the original elements of our
manner in which the original elements of our
consciousness grew up."
consciousness grew up."

PLATE XXI—*Continued*

at fixation 7. As the voice was saying "were" the eye was still located at fixation 7. While the voice was pronouncing the word "seated" the eye was fixated at 8. While the voice was saying "at," "a," and the first part of "table," the eye was located at the ninth fixation, but before the voice finished "table" and started on the next word the eye had moved on to fixation 10 in the first line and then to fixations 1, 2, and 3 in the second line. The voice was evidently lagging at this point. As the voice was pronouncing "upon" and the first part of "which," the eye was at the fourth fixation of the second line. While the voice was finishing the word "which" and saying "many books and papers," the eye was held steadily at the fifth fixation in the second line. This fixation was much longer than the average, lasting for 44 fiftieths of a second. The voice moved over all or part of five words during this fixation, making the eye-voice span at the end of the fixation 22 letter-spaces narrower than it was at the beginning.

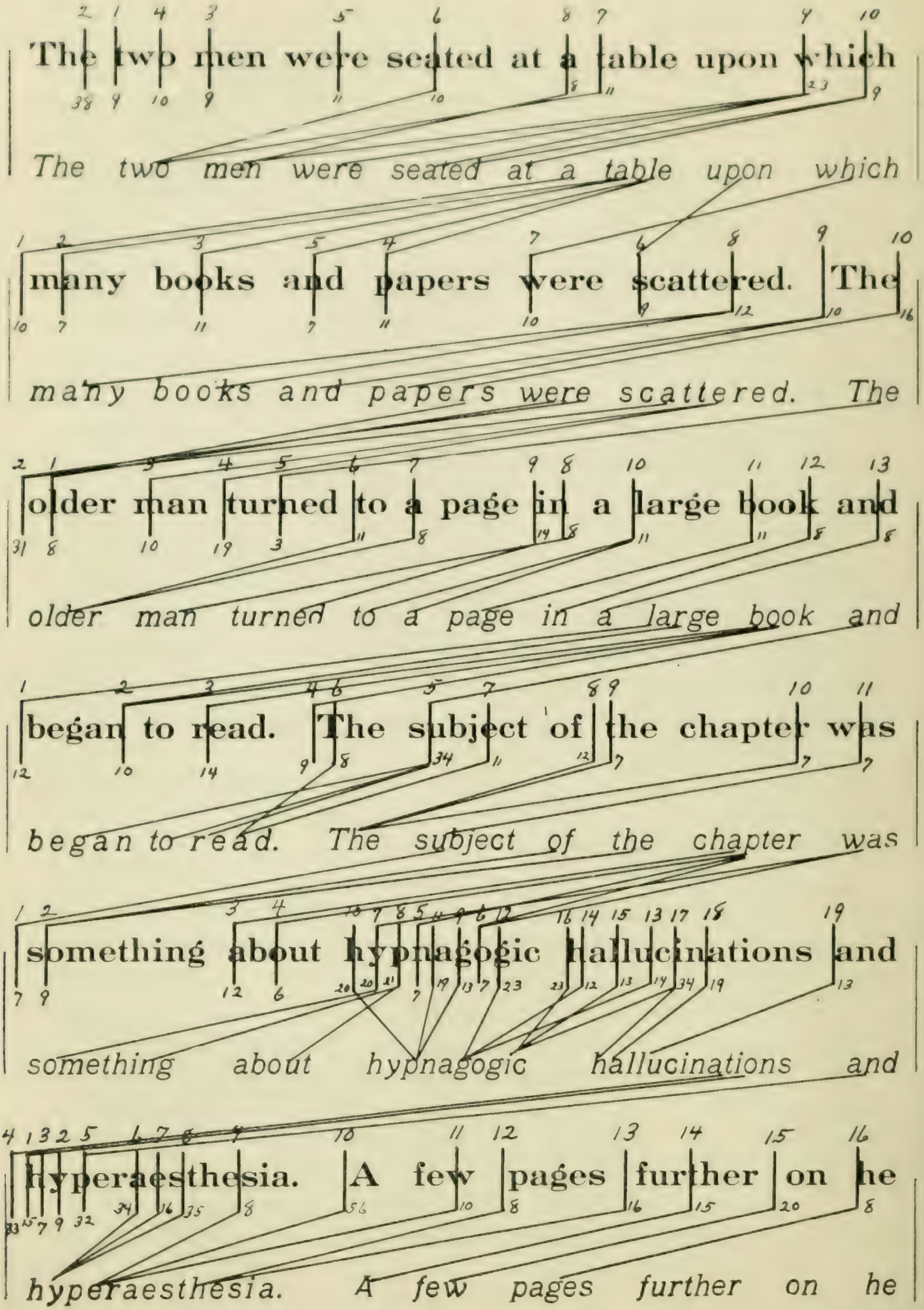
All of the plates are to be read in the same manner. The positions of the eye, while the voice is pronouncing any word, may be found by following the diagonal lines leading from that particular word to the eye-fixations. The position of the voice, while the eye is at any fixation, may be likewise determined by following the diagonal lines leading from that particular fixation to the words in the voice-line. The length of the eye-voice span may be found by counting the number of letter-spaces in the interval between the position of the voice and the eye. If the voice moves over more than one word during a single fixation there will be a maximum and a minimum span, with a range between the spans equal to the distance covered by the voice while the eye is stationary. This maximum and minimum span is well illustrated in the second line of Plate XXI. At fixation 5 in this line the eye remained fixated while the voice covered several words. From the position of the voice to that of the eye at the beginning of the fixation there is a span of 36 letter-spaces, while the distance between the voice and the eye at the end of the fixation is only 14 letter-spaces. In this case the maximum span is 36, the minimum span is 14, and the range of the movement of the voice during the fixation is 22 letter-spaces. The average span at this position would be 25 letter-spaces.

In the third line of Plate XXI an infrequent type of eye-movement occurs which will need explanation. Between the second and fourth fixations in this line the eye made a long sweep to the right, placing the third fixation nearly at the end of the line. An examination of the film will show that there was also an upward movement of the eye, which indicates that instead of fixation 3 being a long look ahead, it was really a regressive movement back to the end of the preceding line. This is indicated in the plate by dotted lines, showing that while this fixation occurred during the series for line 3, it was properly a fixation back upon line 2. This type of movement occurred at intervals in the reading of many of the subjects.

A comparison of the records in Plates XXI–XXIX will bring out the many variations in eye-voice relationship, and will also show the points of general similarity. The elastic nature of the eye-voice span is clearly indicated and the effect of position in the sentence and line can be observed in detail. The effect of the three difficult words introduced in lines 5 and 6 is quite marked, causing an immediate break in the habitual eye-voice relation and reducing the span to nearly zero.

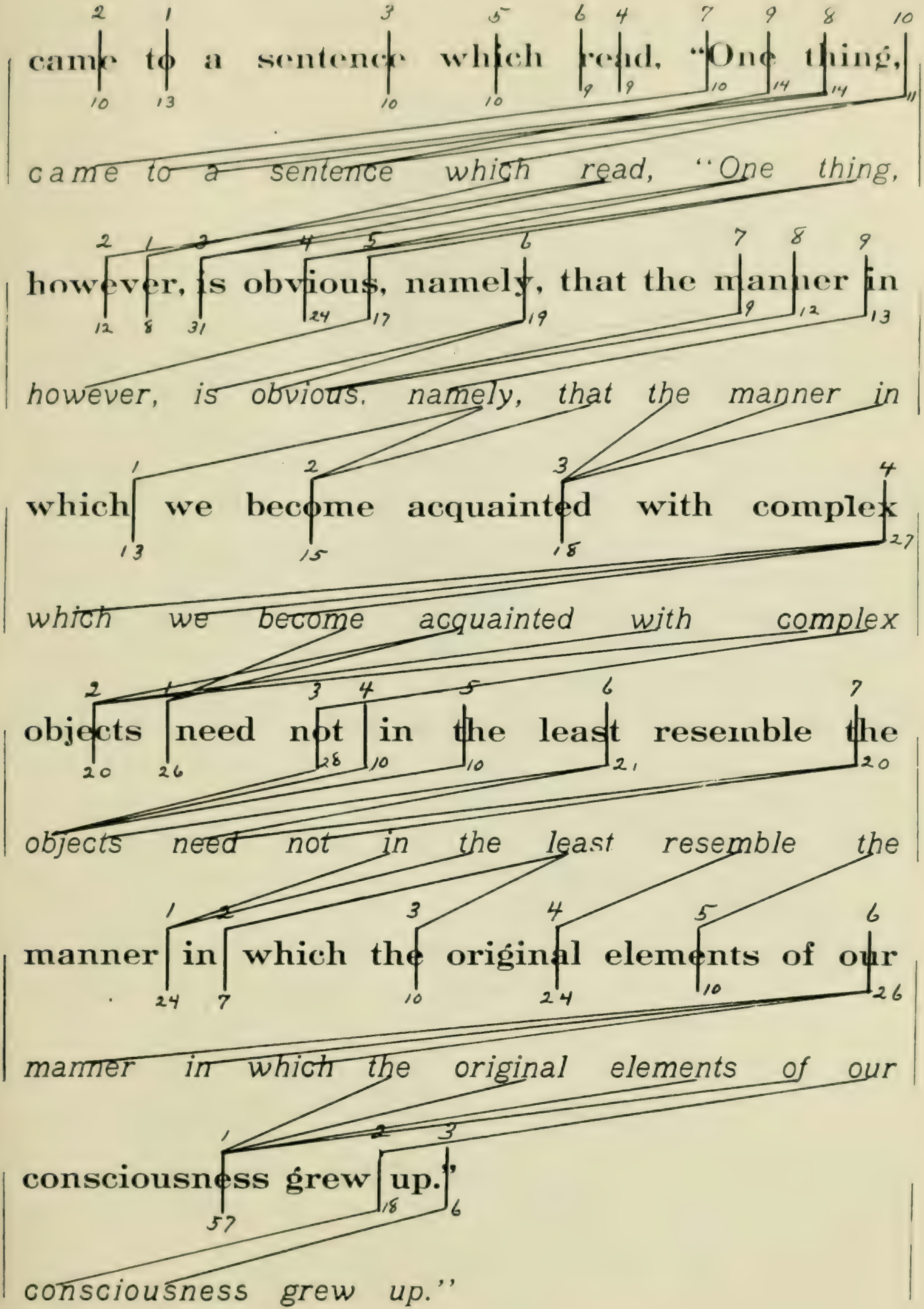
An opportunity is afforded here to check the validity of the method of computing the average span from a few positions in the selection, as was done in the preceding chapter. A comparison shows that when the average span for every fixation is used, the average span for the selection is a little wider than when computed from the eight or nine positions in the paragraph. For Subjects H1 and E1, Plates XXI and XXVIII, the average span obtained by using every fixation was 3.2 letter-spaces longer than when averaged from the nine positions in the paragraph. The reason for this difference is easily explained. The average eye-voice span for the end of a sentence was found to be much narrower than for other points in the selection. For the eight positions used in the elementary-school selection, two were at or near the end of a sentence. The average for the selection, therefore, was influenced by 25 per cent of the samples representing eye-voice spans which varied from the average more than did the other 75 per cent. In the whole elementary selection there were only three sentences and consequently only a few words influenced by being in that position. However, there were forty-three words in the entire selection, which very materially reduced the influence which the narrower span, at the end of sentences, would have on the general average. The same would be true for the high-school selection. Since it has been shown that the relative shortening of the span at the end of a sentence is more evident with good than with poor readers, and since both Subjects H1 and E1 are good readers, the error in the averages for the poor readers would be still less than for these two subjects. Whatever small amount of error does exist for the sampling method, it would affect the results of the preceding chapter in only one respect: it would slightly enlarge the difference in the width

PLATE XXII


The two men were seated at a table upon which
The two men were seated at a table upon which
many books and papers were scattered. The
many books and papers were scattered. The
older man turned to a page in a large book and
older man turned to a page in a large book and
began to read. The subject of the chapter was
began to read. The subject of the chapter was
something about hypnagogic hallucinations and
something about hypnagogic hallucinations and
hyperaesthesia. A few pages further on he
hyperaesthesia. A few pages further on he

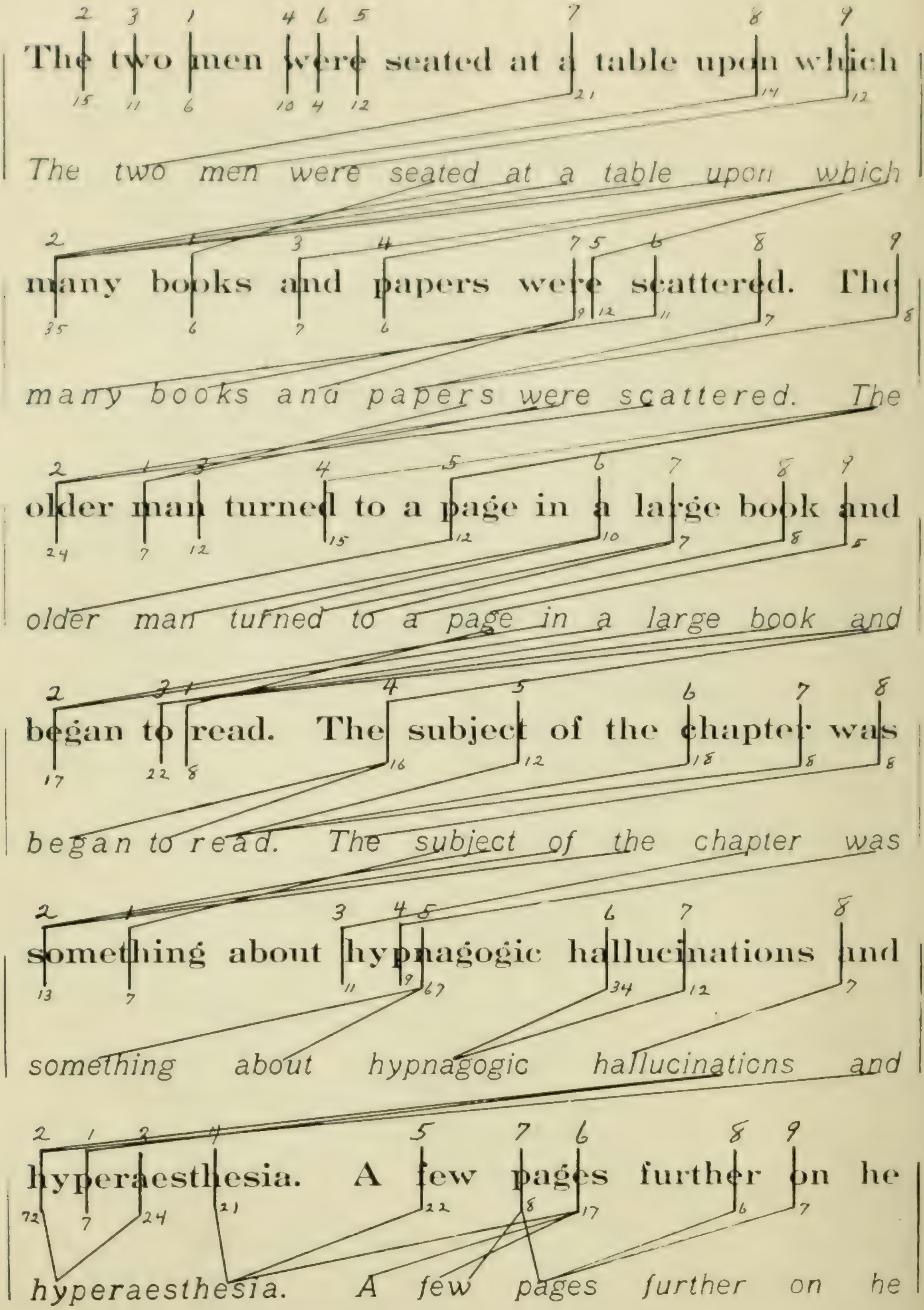
Continuous eye-voice relationship, Subject H5

PLATE XXIII


2 1 3 5 6 4 7 9 8 10
came to a sentence which read, "One thing,
10 13 10 10 9 9 10 14 14 11
came to a sentence which read, "One thing,
2 1 3 4 5 6 7 8 9
however, is obvious, namely, that the manner in
12 8 31 24 17 19 9 12 13
however, is obvious, namely, that the manner in
1 2 3 4
which we become acquainted with complex
13 15 18 27
which we become acquainted with complex
2 1 3 4 5 6 7
objects need not in the least resemble the
20 26 28 10 10 21 20
objects need not in the least resemble the
1 2 3 4 5 6
manner in which the original elements of our
24 7 10 24 10 26
manner in which the original elements of our
1 2 3
consciousness grew up."
57 18 6
consciousness grew up."

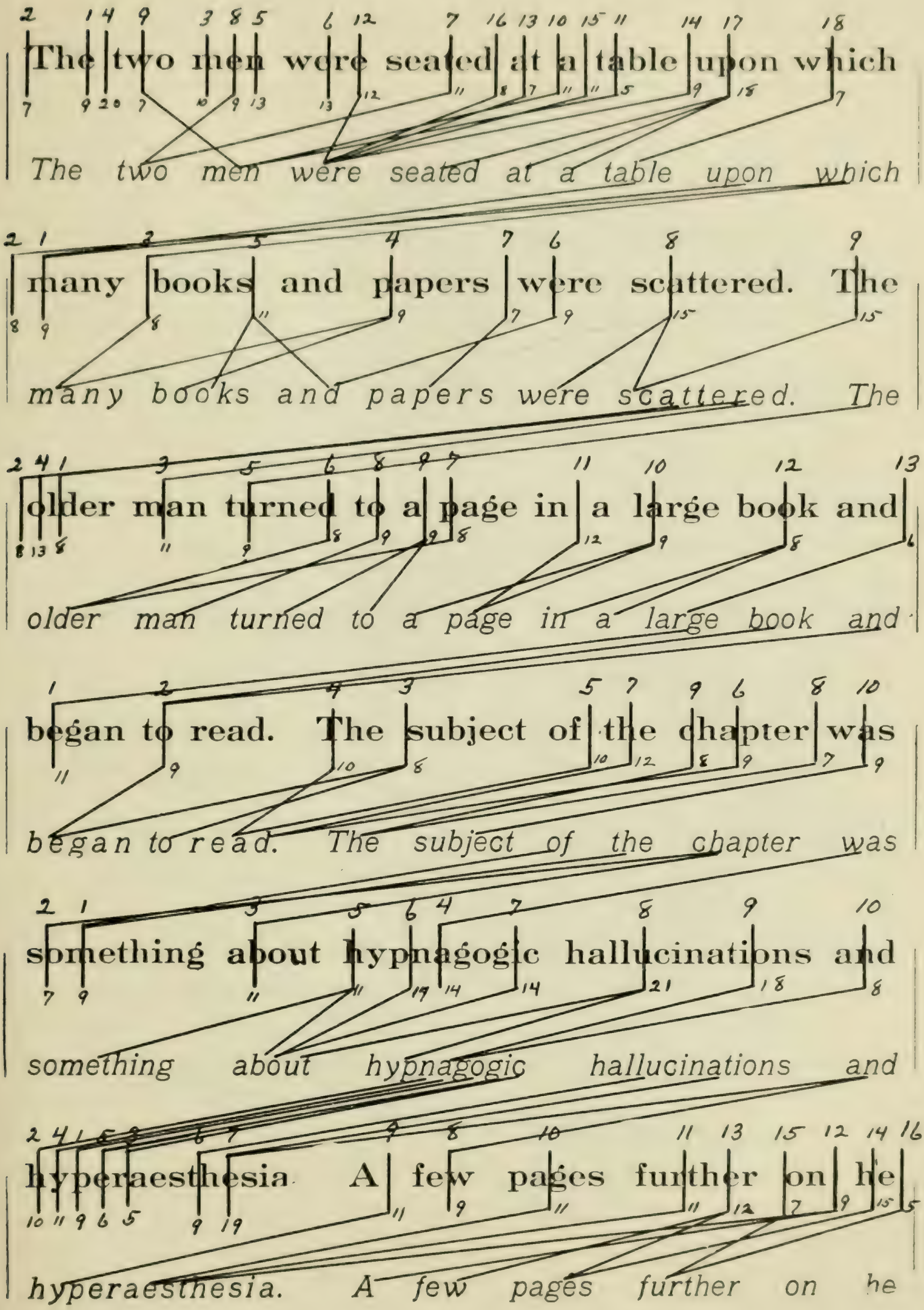
Continuous eye-voice relationship, Subject H8

PLATE XXIV


2 3 1 4 6 5 7 8 9
The two men were seated at a table upon which
15 11 6 10 4 12 21 14 12
The two men were seated at a table upon which
2 1 3 4 7 5 6 8 9
many books and papers were scattered. The
35 6 7 6 9 12 11 7 8
many books and papers were scattered. The
2 1 3 4 5 6 7 8 9
older man turned to a page in a large book and
24 7 12 15 12 10 7 8 5
older man turned to a page in a large book and
2 3 1 4 5 6 7 8
began to read. The subject of the chapter was
17 22 8 16 12 18 8 8
began to read. The subject of the chapter was
2 1 3 4 5 6 7 8
something about hypnagogic hallucinations and
13 7 11 9 67 34 12 7
something about hypnagogic hallucinations and
2 1 3 4 5 7 6 8 9
hyperaesthesia. A few pages further on he
72 7 24 21 22 8 17 6 7
hyperaesthesia. A few pages further on he

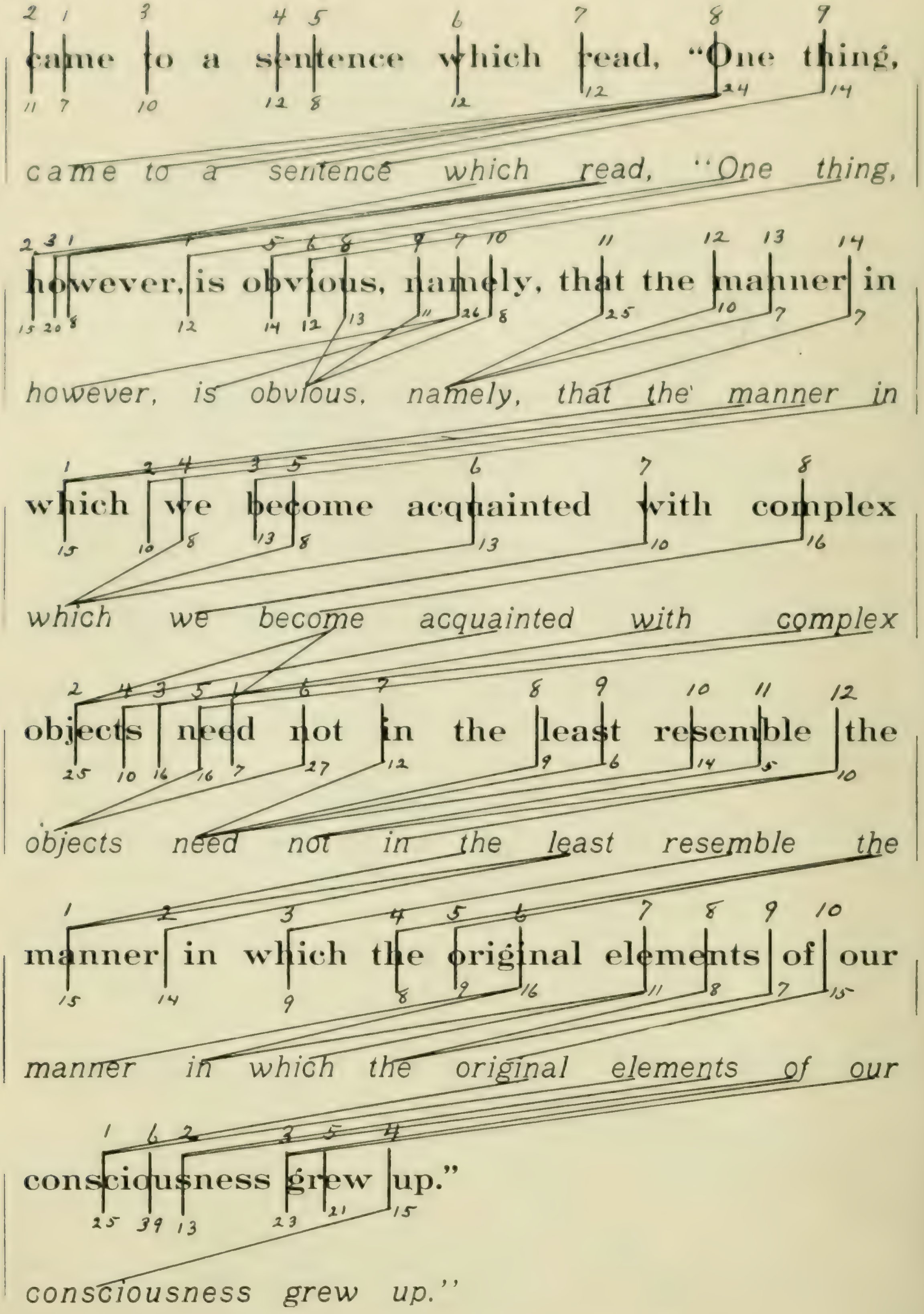
Continuous eye-voice relationship, Subject H10

PLATE XXV


2 14 9 3 8 5 6 12 7 16 13 10 15 11 14 17 18
The two men were seated at a table upon which
7 9 20 7 10 9 13 13 12 11 8 7 11 11 5 9 18 7
The two men were seated at a table upon which
2 1 2 5 4 7 6 8 9
many books and papers were scattered. The
8 9 8 11 9 7 9 15 15
many books and papers were scattered. The
2 4 1 3 5 6 8 9 7 11 10 12 13
older man turned to a page in a large book and
8 13 8 11 9 8 9 9 8 12 9 8 6
older man turned to a page in a large book and
1 2 4 3 5 7 9 6 8 10
began to read. The subject of the chapter was
11 9 10 8 10 12 8 9 7 9
began to read. The subject of the chapter was
2 1 3 5 6 4 7 8 9 10
something about hypnagogic hallucinations and
7 9 11 11 17 14 14 21 18 8
something about hypnagogic hallucinations and
2 4 1 5 3 6 7 9 8 10 11 13 15 12 14 16
hyperaesthesia. A few pages further on he
10 11 9 6 5 9 19 11 9 11 11 12 7 9 15 5
hyperaesthesia. A few pages further on he

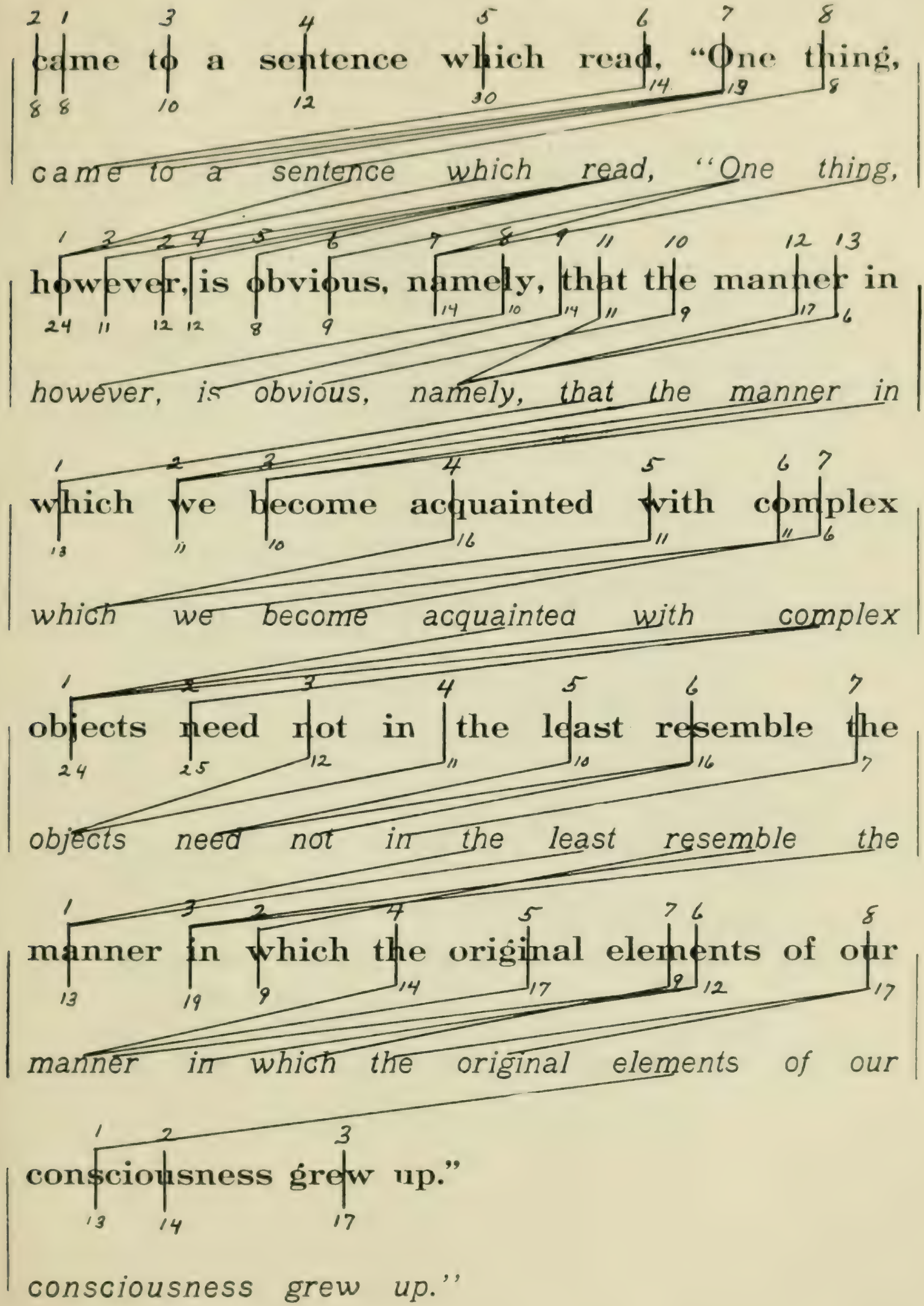
Continuous eye-voice relationship, Subject H22

PLATE XXVI


2 1 3 4 5 6 7 8 9
came to a sentence which read, "One thing,
11 7 10 12 8 12 12 24 14
came to a sentence which read, "One thing,
2 3 1 4 5 6 8 9 7 10 11 12 13 14
however, is obvious, namely, that the manner in
15 20 8 12 14 12 13 11 26 8 25 10 7 7
however, is obvious, namely, that the manner in
1 2 4 3 5 6 7 8
which we become acquainted with complex
15 10 8 13 8 13 10 16
which we become acquainted with complex
2 4 3 5 1 6 7 8 9 10 11 12
objects need not in the least resemble the
25 10 16 16 7 27 12 9 6 14 5 10
objects need not in the least resemble the
1 2 3 4 5 6 7 8 9 10
manner in which the original elements of our
15 14 9 8 9 16 11 8 7 15
manner in which the original elements of our
1 6 2 3 5 4
consciousness grew up."
25 39 13 23 21 15
consciousness grew up."

Continuous eye-voice relationship, Subject H23

PLATE XXVII



came to a sentence which read, "One thing,

came to a sentence which read, "One thing,

however, is obvious, namely, that the manner in

however, is obvious, namely, that the manner in

which we become acquainted with complex

which we become acquainted with complex

objects need not in the least resemble the

objects need not in the least resemble the

manner in which the original elements of our

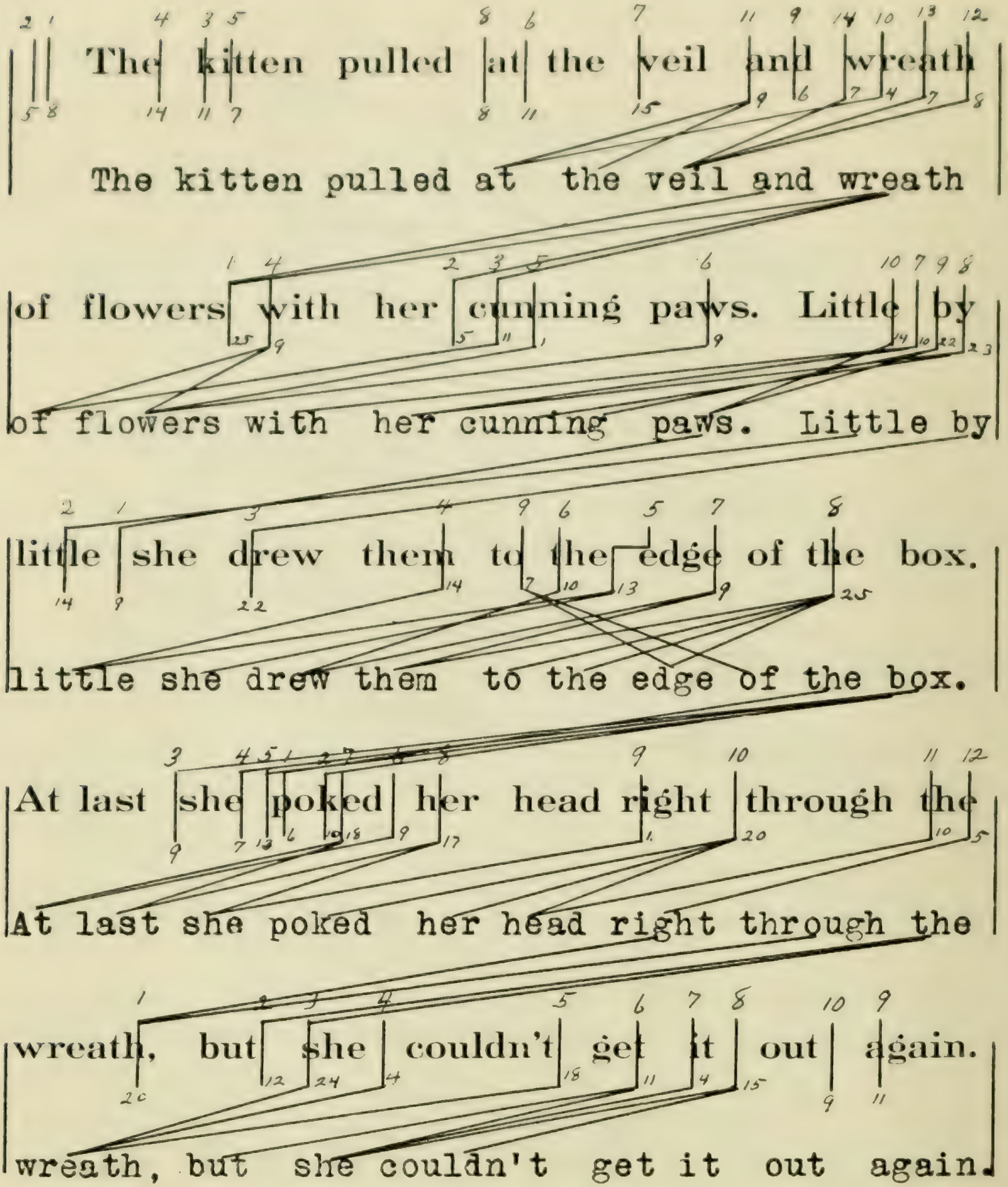
manner in which the original elements of our

consciousness grew up."

consciousness grew up."

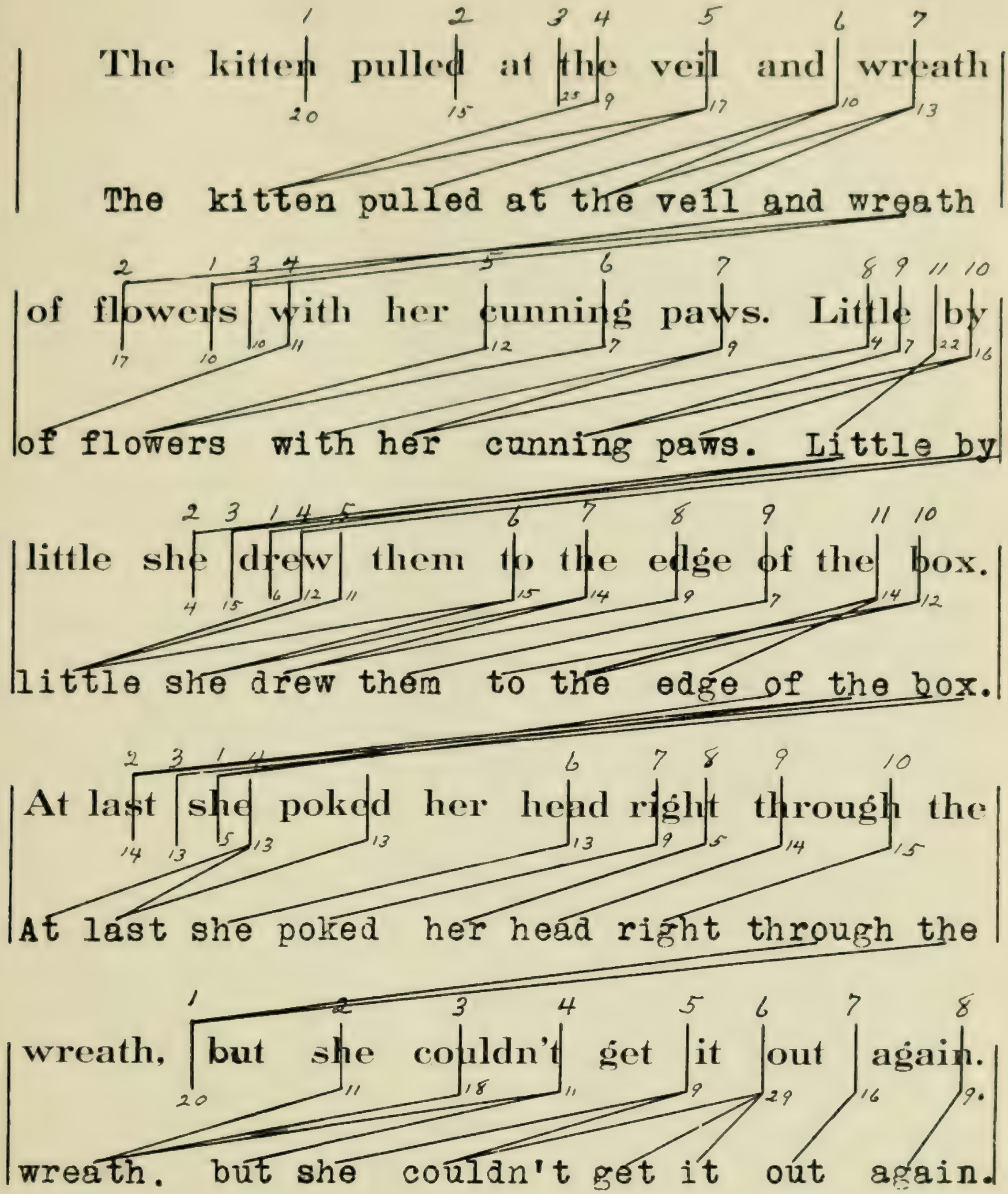
Continuous eye-voice relationship, Subject A3

PLATE XXVIII


The kitten pulled at the veil and wreath
The kitten pulled at the veil and wreath
of flowers with her cunning paws. Little by
of flowers with her cunning paws. Little by
little she drew them to the edge of the box.
little she drew them to the edge of the box.
At last she poked her head right through the
At last she poked her head right through the
wreath, but she couldn't get it out again.
wreath, but she couldn't get it out again.

Continuous eye-voice relationship, Subject E1

PLATE XXIX


The kitten pulled at the veil and wreath
The kitten pulled at the veil and wreath
of flowers with her cunning paws. Little by
of flowers with her cunning paws. Little by
little she drew them to the edge of the box.
little she drew them to the edge of the box.
At last she poked her head right through the
At last she poked her head right through the
wreath, but she couldn't get it out again.
wreath. but she couldn't get it out again.

Continuous eye-voice relationship, Subject E5 of span which was shown to exist between the good and the poor readers. It would have no influence on the other results since they are all in the nature of relative comparisons and whatever difference exists would exist for the whole group.

ELASTIC NATURE OF THE EYE-VOICE SPAN

One of the characteristic features of the eye-voice span is its variation in width from word to word through the selection. The span is sometimes very wide and sometimes narrow, apparently expanding and contracting according to the demands made by the material read. Table XIII shows this elastic nature of the span for four lines of the reading of Subject H1. This table gives the maximum and the minimum eye-voice span, the range, and the duration of the pause for each

TABLE XIII

ELASTICITY OF EYE-VOICE SPAN—SUBJECT H1

Line and Fixation Number	Maximum Eye-Voice Span	Minimum Eye-Voice Span	Range of Span	Length of Fixation
II-1	18	17	1	12
II-2	15	14	1	10
II-3	24	23	1	14
II-4	32	25	7	9
II-5	36	13	23	44
II-6	18	10	8	13
III-1	21	19	2	7
III-2	16	14	2	7
III-3	7	5	2	11
III-4	24	22	2	11
III-5	14	11	3	11
III-6	17	15	2	13
III-7	27	19	8	14
III-8	32	21	11	15
III-9	13	6	7	16
IV-1	30	29	1	14
IV-2	24	11	13	22
IV-3	21	12	9	20
IV-4	24	10	14	32
IV-5	24	23	1	17
IV-6	26	23	3	12
IV-7	25	17	8	6
XI-1	44	34	10	12
XI-2	41	31	10	12
XI-3	39	37	2	9
XI-4	45	41	4	7
XI-5	46	37	9	14
XI-6	5	2	3	10
XI-7	36	29	7	11

fixation in lines 2, 3, 4, and 11. In the second line the maximum span is comparatively small, then large and finally small again. In the fourth line the maximum span is wide for every fixation but the minimum span shows considerable variation. In line 11 there is an exceptionally wide maximum span for every fixation except the sixth. The reason for this variation is that fixation 6 makes a long regressive movement which cuts the span nearly to zero. The eye-voice span of this subject shows an elasticity both within the line and from line to line. The relation of the eye and voice is apparently adjusted according to the demands made upon the reader by the material. As noted in the preceding chapter, the beginning and end of a sentence demand a different type of eye-voice span. There are without doubt other factors which influence the width of the span, among which difficult words and difficult meaning would have a place. It has alreadv been shown that the eye-voice span of the immature reader is narrow, while pupils with more mature reading habits have a wider span. An examination of Plates XXI, XXII, XXIV, and XXV shows very clearly that when the difficult words in lines 5 and 6 are encountered the subjects who are mature readers return at once to a type of reading which can be described as less advanced and keep their eye and voice very close together. The elastic nature of the eye-voice span is very evident when such difficult words are encountered. A more detailed anaylsis of the reaction to difficult words will be given in the latter part of this chapter.

RELATION OF EYE-VOICE SPAN TO LENGTH OF FIXATIONS

An examination of the records of the subjects used in this investigation will show that while the median duration of a fixation pause varies from 9 to 13 fiftieths of a second, there frequently occur fixations which are very much longer. A tabulation of the fixation pauses of nineteen high-school subjects shows an average for each subject of 14 fixations which are more than 20 fiftieths of a second in length. The length of these long fixations varies from 20 to 93 fiftieths of a second. This unusual behavior on the part of the eye calls for an explanation. It was thought that an analysis of the continuous relationship of the eye and voice might help to explain the long fixations by showing what the voice was doing during those comparatively long intervals. The cause of these long fixations may be due to a number of factors. One possible hypothesis is that a long fixation occurs when the eye reaches too great a distance ahead of the voice, and that the eye remains fixated until the voice catches up to a convenient position, when the eye moves forward again. In terms of this hypothesis a long fixation would mean a period during which the voice was trying to catch up with the eye.

In order to test this hypothesis a study was made of the ten longest and ten shortest fixations for each of ten subjects. The average maximum and minimum spans and the range were tabulated for each subject. If the hypothesis were true, the maximum span and the range should be greater for the long fixations than for the short ones. Such a condition would be evidence that, in case of the long fixations, the eye had been leading by too wide a span and that a long fixation was provided for the voice to catch up. The result of the comparison of the fixations of the ten subjects is given in Table XIV. The table should be read as follows: The record of Subject E1 shows, for the ten longest fixations, an average maximum span of 18.6 letter-spaces an average minimum span of 11.9 letter-spaces, and a range of 6.7 spaces; and for the ten shortest fixations, a maximum span of 15.3 letter-spaces, a minimum span of 13.4 spaces and a range of 1.9 spaces.

TABLE XIV

Relation of Eye-Voice Span to Length of Fixations

Subject	Ten Longest Fixations			Ten Shortest Fixations		
	Maximum Span	Minimum Span	Range	Maximum Span	Minimum Span	Range
E1..........	18.6	11.9	6.7	15.3	13.4	1.9
E5..........	14.9	8.1	6.8	16.7	13.5	3.2
E8..........	14.1	9.3	4.8	13.8	11.6	2.2
H1..........	27.7	16.0	11.7	29.6	24.3	5.3
H5..........	18.9	10.7	8.2	17.6	15.0	2.6
H8..........	31.4	21.6	9.8	25.9	22.0	3.9
H10........	22.8	11.8	11.0	23.0	19.6	3.4
H22........	22.5	13.9	8.6	15.0	12.2	2.8
H23........	20.8	11.3	9.5	18.6	15.2	3.4
A3..........	20.4	11.5	8.9	20.0	17.0	3.0
Average...	21.2	12.6	8.6	19.6	16.4	3.2

The averages for all of the ten subjects do not fully justify the hypothesis. The maximum span for the long fixations is greater than that for the short fixations, but only by a small amount. It is not a satisfactory explanation to say that an average span of 21.2 letter-spaces was so great as to cause a very long fixation, while a span of 19.6

letter-spaces was not found inconvenient and was accompanied by the shortest fixations. The difference is not great enough to justify the hypothesis, and the conclusion must be drawn that width of eye-voice span is at least not a large factor in the cause of long fixations.

The average range, for all subjects, for the long fixations is 8.6 letter-spaces, while for the short fixations it is only 3.2 letter-spaces. This cannot be regarded as an explanation of the cause of the long fixations, but it merely shows that the voice is moving over a greater range during the long pauses.

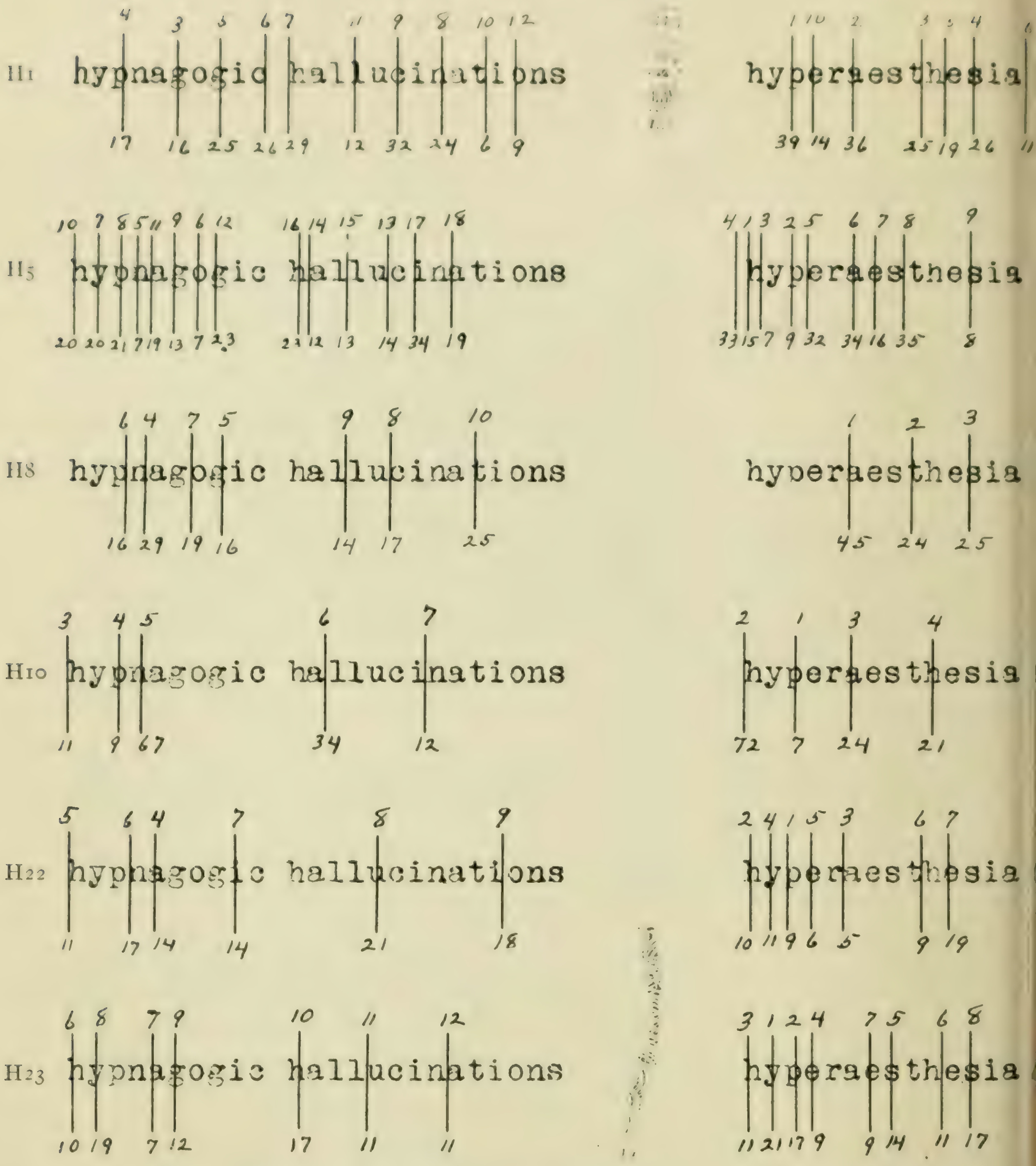
The data presented in Table XIV cannot be regarded as sufficient evidence to establish a causal relationship between a long eye-voice span and a long fixation pause. When the span becomes too long for convenience the eye seems to react by a series of short fixations covering small intervals as often as by a single long fixation. The eye is the controlling factor rather than the voice, and other factors of perception must operate to lengthen the eye pauses.

A cue to a possible cause of the long fixations may be found from another source than the eye-voice span. The eye-movements of all high-school subjects were radically modified when the three difficult words in lines 5 and 6 were reached. These words were new to all of the high-school subjects. Two characteristic differences are evident in the behavior of the eye toward these words. The number of fixations is greater and the percentage of long fixations is larger when the difficult words are encountered.

Plate XXX shows a comparison of the eye-movements of six high-school subjects in reading these three words. The column of numbers at the right of the plate gives the median length of all fixations. The first line of the plate gives the record of Subject H1. The median length of the fixations of this subject for the whole selection was 12 fiftieths of a second. In reading these words 13 of the 17 fixations are longer than the median. Of these 13 fixations, 9 are more than twice as long as the median for the selection. Subject H5, in the next line, makes 23 fixations on the three words, 18 of which are longer than the median. Subject H10, in the fourth line, makes only 9 fixations of which 6 are greater than the median. Two of these 6 are very long, however, being 67 and 72 fiftieths of a second.

The results shown by Plate XXX make it clear that difficult words are one cause of long fixations. They suggest that an explanation of the occurrence of long fixations may be found in the content of the reading selection. In order to test this possibility, a study was made of

PLATE XXX



Effect of new and difficult words upon eye-movements. Six high-school subjects all fixations which were longer than 20 fiftieths of a second in the records of nineteen subjects. The readings of these nineteen subjects showed a total of 250 fixations which were over 20 fiftieths of a second in length. The selection which these subjects read contained ninety words. If the long fixations simply occurred at random there should be an average of 2.9 for each word in the paragraph. The number and duration of these long fixations, for each word in the selection, are given in Plate XXXI. This plate shows that three of the pauses occurred on the first word, "the," and that their duration was 38, 22, and 30 fiftieths of a second. Only one long fixation occurred on the word "two," three fell on the word "men," two on "were," etc. The point of interest in the plate is that the long fixations are not distributed in a random fashion with 2.9 falling on each word, but that they occur much more frequently on certain words than on others. The greatest number of long fixations fall upon the words "hyperaesthesia," "hypnagogic," and "hallucinations," these words receiving 31, 22, and 16 fixations respectively. Since these are the most difficult words in the paragraph, there can be no doubt that difficulty is one factor causing long fixation pauses. It will be noticed that thirteen words each receive as many as six or more of these long fixations. These words are underlined in the plate.

If the same cause operates to produce long fixations on all of the words, there must be some point of difficulty connected with the words receiving a larger number of such pauses. The word "consciousness" in the last line and the word "grew" following it appear to present difficulties. This is doubtless due to the fact that "consciousness" is not a common word to high-school pupils, and when used with "grew" it presents an idea which is difficult and unfamiliar. The phrase "objects need not" in the third from the last line presents familiar words in an unfamiliar combination. The whole quoted sentence contains a difficult thought, and by the time this phrase is reached the difficulties come to a focus. The fact that "objects" has the same form both as a noun and as a verb may add to the confusion. No explanation is offered as to why "namely" in the eighth line should receive six long fixations. In line 6 the word "further" is not as common with high-school pupils as the form "farther" which might account for the difficulty. In line 4 the words "began" and "read" both present tense difficulties. The word "began" is often confused with "begun." The word "read" is spelled alike for both present and past tense but is pronounced differently and often causes trouble in reading. No explanation is offered for the word "subject."

PLATE XXXI

The	two	men	were	seated	at	a	table	upon	which
38	20	21	20	28		21	23		23
22		21	23	28		27	25		20
30		21					20		20

many	books	and	papers	were	scattered.	The
35	35			21	44	28
26					22	21
23						27
36						
22						

older	man	turned	to	a	page	in	a	large	book	and
31	24	21		31	22		20			21
30	21	22		30			23			27
24	24	25								
20	20									
32	23									

began	to	read.	The	subject	of	the	chapter	was
20	22	24	20	34	22	22	21	22
22	36	28	22	23	22		20	
28		20		32				
21		21		32				
20		25		38				
20		30		23				
				24				

something	about	hypnagogic	hallucinations	and
		20-26-67-59	21-24-34-23	30
		20-29-31-22	23-34-25-53	
		21-24-42-42	32-26-21-43	
		23-29-32-20	20-22-23-23	
		25-29-21-23		
		24-43		

hyperaesthesia.	A	few	pages	further	on	he
34-34-22-25-29-24	56	28	20	24	24	
33-27-23-34-26-25	22	22		22		
74-36-23-21-35-29		21		20		
40-32-26-22-21-43		30		20		
23-21-24-45-25-32		52		20		
37				22		

Location of long fixation pauses, 19 subjects

PLATE XXXI*a*

came	to	a	sentence	which	read,	“One	thing,
24			21	30 20 23 29	20	21 24	27 25

however,	is	obvious,	namely,	that	the	manner	in
20 24 21 26 30	31 23 26	24 31 21	22 29 26 23 24 22				

which	we	become	acquainted	with	complex
			20 20 22		20 20 27

objects	need	not	in	the	least	resemble	the
35-38 20-43 25-24 22-23	34-26 25-38 26-24 21	28 20 27 20 21 23 32	22	24	21 22	22 28 21	22 20

manner	in	which	the	original	elements	of	our
24		22		34 24 27	20 30 21		38 26 20

consciousness	grew	up.”
25-24-23 39-40-22 20-57-23 20-22	93 29 21 30 26 24	27

PLATE XXXI—*Continued*

The results of this form of tabulation indicate that difficulty of material must have some relation to the length of fixations. No other explanation is apparent which could account for the fact that only six long fixations fall on the ninth line while thirty-one fall on the tenth.

A similar form of study was applied to the elementary pupils. Their records showed that long fixations were distributed over all the words of the selection. Apparently even simple words present difficulties to a child in the elementary school.

The interpretation of the foregoing data must be related to the development of reading habits. The records of the elementary subjects, whose reading habits are still immature, show that long fixations are frequent and occur all through the selection. Evidently long fixations are characteristic of immature types of reading. The high-school and adult subjects represent more mature readers. In general they have outgrown the long fixation habits. However, when words of special difficulty or difficult phrases are encountered, they return immediately to the primitive type of habits characteristic of the immature reader. Earlier in this chapter the same kind of a reversion to primitive reading habits was observed in the narrowing of the eye-voice span when difficult words were encountered.

The conclusion to be drawn regarding the long fixations is that width of eye-voice span is not a determining factor. The return to immature reading habits caused by encountering difficulties in the reading material is apparently a more adequate explanation.

CHAPTER IV

THE EYE-VOICE SPAN AND THE RECOGNITION OF MEANING

MATERIAL AND METHOD USED

The use of a photographic method gives the most accurate measure of the eye-voice span. The general use of this method is limited, however, by the very elaborate apparatus which is involved. It would be desirable to have a device which would give objective information regarding the eye-voice span without use of apparatus. Quantz, in his study cited in the introductory chapter, called attention to a fact which is of special significance. He suggested that certain words which are spelled alike but pronounced differently might be used to determine eye, voice, and meaning relationships. This chapter reports the testing of such a device by photographing the eye-movements which occur when such words are encountered in the reading.

A paragraph of twelve lines was constructed, which contained six words which are spelled alike but pronounced differently. The subjects were not informed that the paragraph was unusual in any respect, but were instructed to read it carefully in order to get the meaning. The subjects read orally and were not allowed to glance over the selection before beginning to read. The test passage used was as follows:

The boys' arrows were nearly gone so they sat
down on the grass and stopped hunting. Over
at the edge of the woods they saw Henry
making a bow to a little girl who was coming
down the road. She had tears in her dress
and also tears in her eyes. She gave Henry a
note which he brought over to the group of
young hunters. Read to the boys it caused
great excitement. After a minute but rapid
examination of their weapons they ran down
the valley. Does were standing at the edge
of the lake making an excellent target.

The test words in the paragraph are "bow" in line 4, "tears" in line 5, "tears" in line 6, "read" in line 8, "minute" in line 9, and "does" in line 11. The paragraph is so constructed that the meaning of these words is not evident until the next few words in the sentence are read. For example, in line 5, the word "tears" is ambiguous until the word "dress" is reached. The hypothesis in regard to the eye-voice span is that no error will be made in the reading if the span is wide enough to enable the reader to take in the word "dress" before pronouncing the word "tears." If the span is not wide enough to do this, there is a strong probability of error. By varying the distance between the test words and the part of the sentence which qualifies it, a rough measure of the width of the eye-voice span can be secured. If this hypothesis is correct, subjects having a wide eye-voice span should make fewer errors than those whose span is narrower.

The use of such a paragraph will also help to answer the question as to where the recognition of meaning occurs in the reading process. Does the recognition of meaning accompany the eye or the voice, or is it intermediate? A similar question could be raised in regard to silent reading.

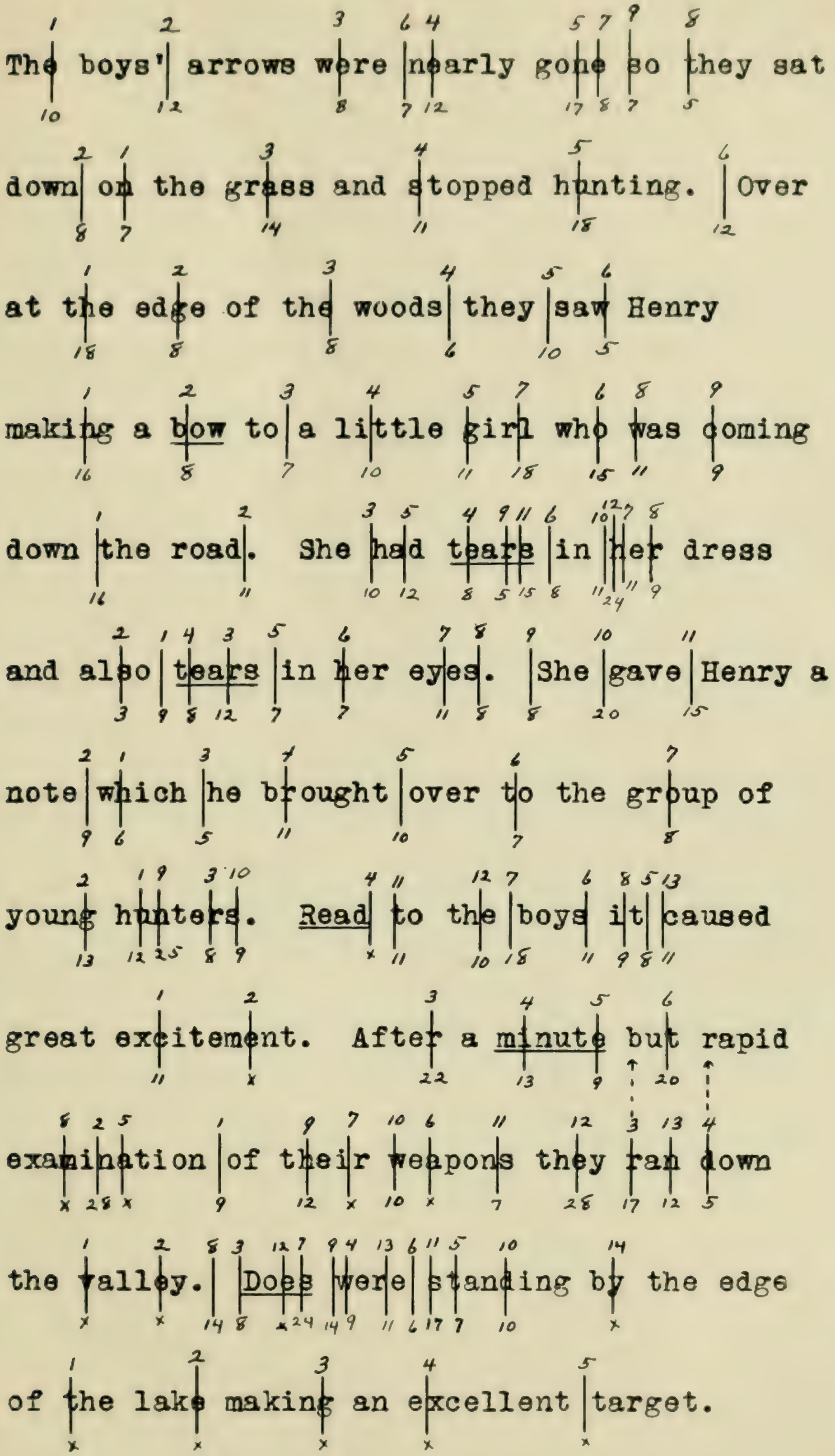
ORAL READING OF TEST PASSAGE

Photographs were made of the eye-movements of a number of subjects while reading this selection. A comparison of the behavior of the eye, when encountering one of the test words, with the dictaphone voice record will show how closely the two are related. Plates XXXII–XXXIV give the records of the oral reading of this selection by three subjects.

Plate XXXII gives the record of Subject H13, a good reader from the junior class. In the reading of the first line of the selection, a long regressive movement occurred at the sixth fixation, carrying the eye back over the word "nearly." The dictaphone record showed that he had trouble with this word, hesitating before pronouncing it and repeating the first syllable as follows, "nea – – nearly." The fact that the fifth fixation, the one just before the regressive movement, fell on the word "gone" would indicate that the eye had passed the word "nearly" but was recalled when the voice reached it. Evidently the eye did not fully recognize the meaning of the word when it fixated on it the first time, and the regressive movement occurred to make sure of the meaning.

The next difficulty which is evident in the record of this subject is found in the fifth line on the word "tears." This was one of the test

PLATE XXXII



The boys' arrows were nearly gone so they sat
down on the grass and stopped hunting. Over
at the edge of the woods they saw Henry
making a bow to a little girl who was coming
down the road. She had tears in her dress
and also tears in her eyes. She gave Henry a
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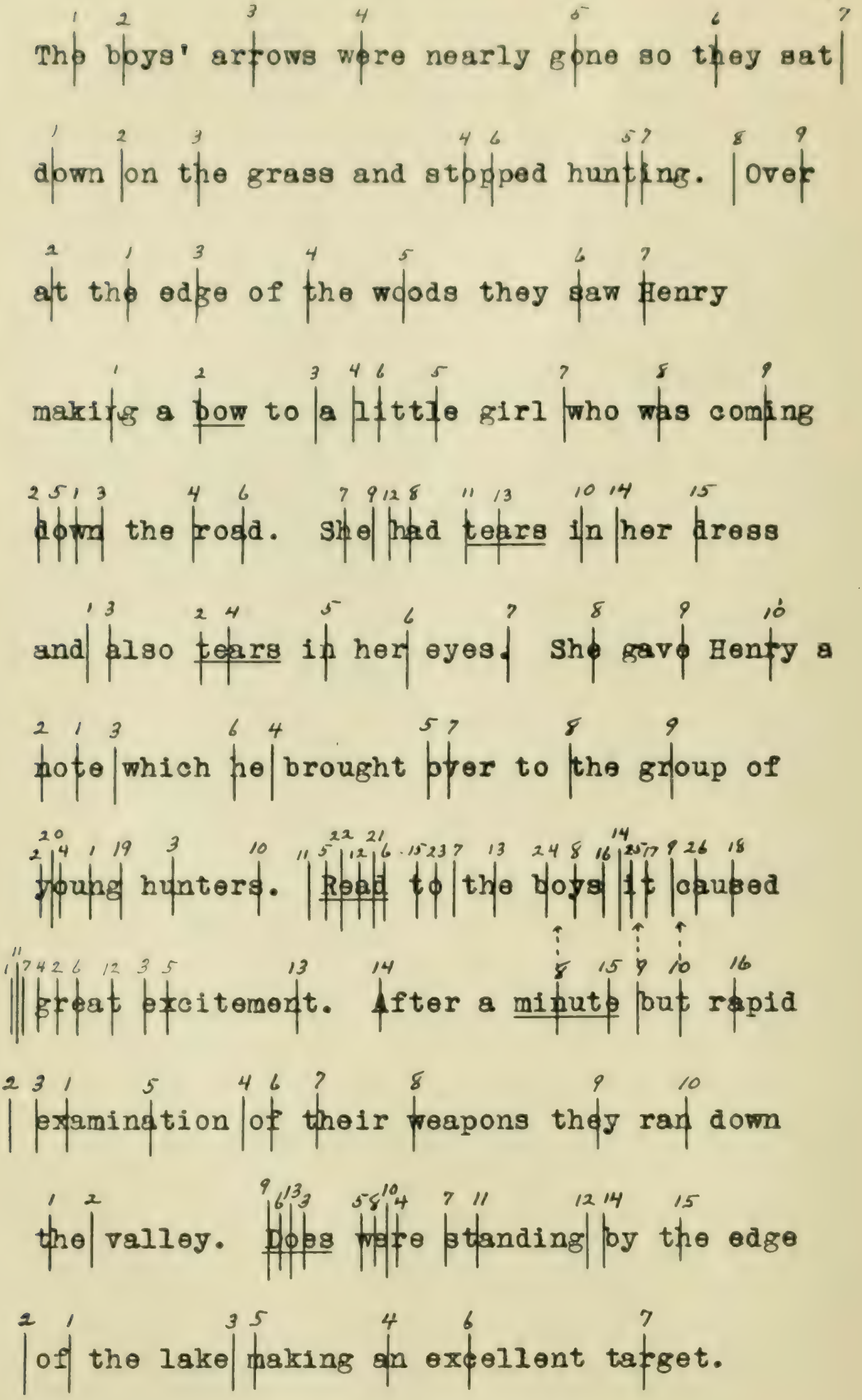
young hunters. Read to the boys it caused
great excitement. After a minute but rapid
examination of their weapons they ran down
the valley. Does were standing by the edge
of the lake making an excellent target.

Oral reading of test passage by Subject H13

PLATE XXXIII



The boys' arrows were nearly gone so they sat
down on the grass and stopped hunting. Over
at the edge of the woods they saw Henry
making a bow to a little girl who was coming
down the road. She had tears in her dress
and also tears in her eyes. She gave Henry a
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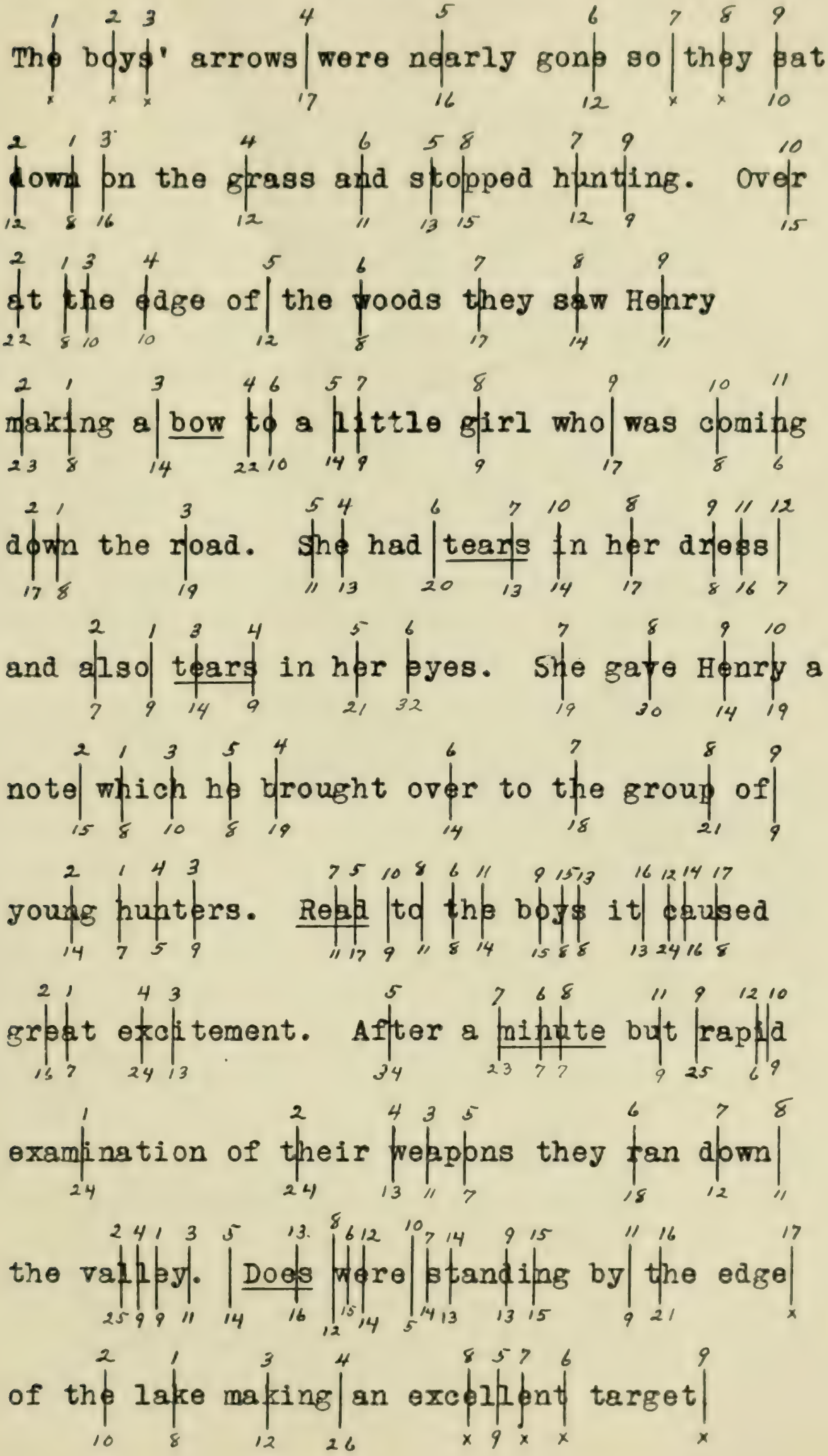
young hunters. Read to the boys it caused
great excitement. After a minute but rapid
examination of their weapons they ran down
the valley. Does were standing by the edge
of the lake making an excellent target.

Oral reading of test passage by Subject A1

PLATE XXXIV



The boys' arrows were nearly gone so they sat
down on the grass and stopped hunting. Over
at the edge of the woods they saw Henry
making a bow to a little girl who was coming
down the road. She had tears in her dress
and also tears in her eyes. She gave Henry a
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young hunters. Read to the boys it caused
great excitement. After a minute but rapid
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the valley. Does were standing by the edge
of the lake making an excellent target

Oral reading of test passage by Subject A3 words and it caused the reader a great deal of trouble. The eye passed and returned to the word twice before the correct meaning was recognized. The dictaphone record read as follows: "She had – ah – tear (error) – – tears (correct) in her dress." The difficulty experienced is clearly reflected in the eye-movements. In line 6 the reader approached "tears" very cautiously and was successful in avoiding an error.

In the eighth line the word "read" caused a period of confusion for the eye. Following the eye-fixations in serial order, it will be seen that the difficulty did not appear until after the fifth fixation just following the word "it." The dictaphone shows that the voice proceeded to the word "it" before being fully aware of its error. The record was as follows: "Read (error) to – – read (error) to the boys – – – read (correct) to the boys it – –."

In the ninth line the word "minute" was mispronounced and left uncorrected. The voice repeated the phrase "but rapid" twice. The accompanying eye-movement may be seen in the third and fourth fixations of the next line. These fixations, as indicated by the dotted line, were regressive movements to the last two words of the ninth line.

In the eleventh line the voice made a very long hesitation before pronouncing "does," but succeeded in pronouncing it without error. The film record shows that the eye passed back and forth over the word several times before the meaning became clear. The subject had evidently become cautious and did not attempt to pronounce the word until the meaning was recognized.

Plate XXXIII gives the record of Subject A1, a college student ranked as a poor reader. A correlation between eye and voice difficulties appears here as in the case of Subject H13. The word "bow" in line 4 was mispronounced but was immediately corrected. The regressive movement from the fifth to the sixth fixation shows the location of the eye at the time of the readjustment.

The word "tears" in line 5 was mispronounced and passed without correction. The voice also repeated the word "had" just preceding "tears."

The voice had a very difficult time with the word "read" in the eighth line, repeating the phrase three times before reading it correctly. The reading was as follows: "– – – read (error) to – – – – – read (error) to the boys it caused – – – read (correct) to the boys – – – – – – –." The difficulty in eye-movements was fully as great, the eye making 26 fixations on the line. The confusion in eye-movements in the next line shows that the eye had made at least 10 fixations there before the reading was corrected. Fixations 8, 9, and 10 in line 9 were regressive movements back to the end of line 8.

The reaction to the word "does" in line 11 was a very long hesitation on the part of the voice, the word finally being pronounced without error. The fixations show that the eye was very busy during the pause and that it made a minute survey of both "does" and "were."

Plate XXXIV, showing the record of Subject A3, brings out the same kind of correlation between voice and eye difficulty. This subject made errors in pronouncing "bow" in line 4, "tears" in line 5, "read" in line 8, "minute" in line 9 and "does" in line 11. More or less confusion in eye-movements can be observed in all of these positions on the plate.

The records of these subjects make it very evident that certain characteristic confusions in eye-fixations accompany points of difficulty in oral reading. A comparison of the percentage of errors made in the reading of this selection with the eye-voice span as determined by the other part of this study would show whether any relation exists between width of eye-voice span and these same oral-reading difficulties.

TABLE XV

Errors in Word Test Paragraph—Oral Reading

Subject	Number Test Words in Passage	Number Correct	Number Errors Corrected	Number Errors Not Corrected	Average Eye-Voice Span
H4	5	3	0	2	10.0
H5	6	2	3	1	12.0
H6	6	1	4	1	12.4
H11	5	0	1	4	9.6
H12	5	3	1	1	13.7
H13	6	2	3	1	13.8
H14	6	4	0	2	17.6
H15	6	3	1	2	12.3
H16	6	4	0	2	8.5
H18	6	2	2	2	11.5
H19	6	4	1	1	12.8
H20	6	4	2	0	23.0
A1	6	2	2	2	12.2
A2	6	1	1	4	9.3
A3	6	1	2	3	13.6

Table XV gives the data for the reading of a selection containing this kind of test words by 15 subjects. The table shows the number of test words in the passage, the numbers pronounced correctly the first time, the number of errors which were corrected, the number of errors not corrected, and the average eye-voice span. Table XVI is made up from Table XV, and shows the relation of errors in the test paragraph to the eye-voice span. This table is based upon the percentage of test words in the paragraph which were pronounced correctly at first or were immediately corrected. It should be read as follows: One subject pronounced from 1 to 20 per cent of the words correctly and had an

TABLE XVI

RELATION OF ERRORS IN WORD TEST PARAGRAPH TO EYE-VOICE SPAN

Number of Subjects	Test Score—Per cent of Words Correct and Corrected	Average Eye-Voice Span
1	1–20	9.6
1	21–40	9.3
2	41–60	11.3
6	61–80	12.6
5	81–100	14.8

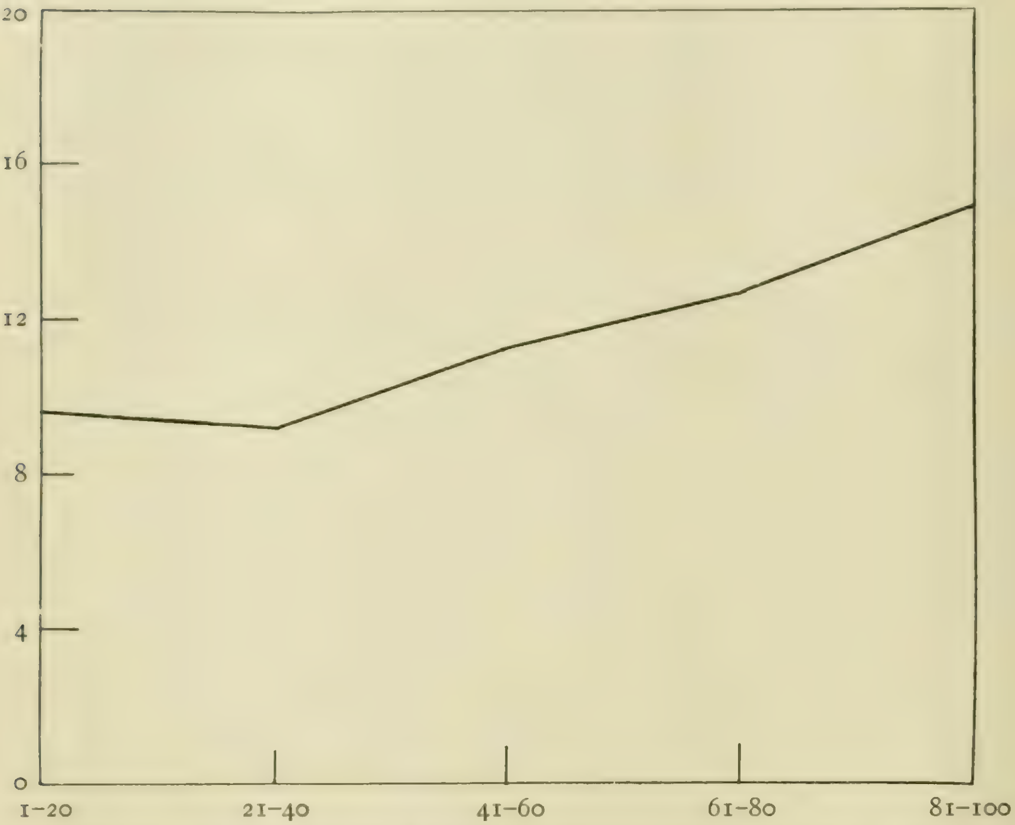


FIG. 12.—Relation of errors in word test paragraph to eye-voice span. Percentage of words correct shown on horizontal axis. Average eye-voice span on the vertical axis.

average span of 9.6 letter-spaces, one pronounced from 21 to 40 per cent correctly and had an average span of 9.3 letter-spaces, two pronounced from 41 to 60 per cent correctly and had an average span of 11.3 spaces, etc. The same data are shown graphically in Figure 12. A distinct positive correlation is evident between a wide eye-voice span and a high score in reading the selection. A subject with a wide span has an opportunity to interpret the meaning in larger units and is able to get the correct meaning before the voice reaches the points of difficulty.

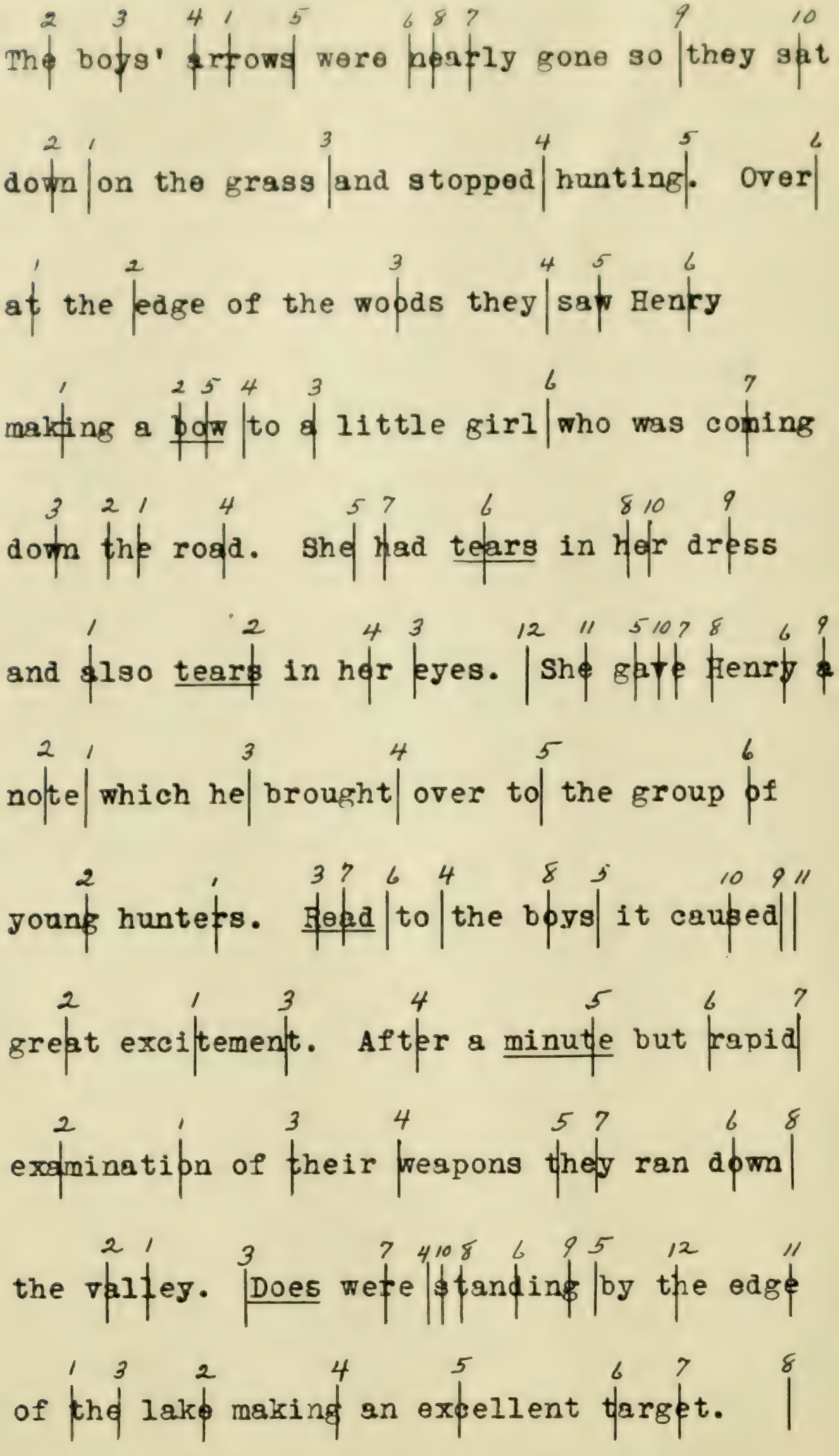
Two facts stand out clearly as a result of the use of the paragraph containing the test words. The first is that difficulties in the recognition of meaning are reflected in the character of the eye-movements. The second is that subjects with a wide eye-voice span have less difficulty with such material than do subjects with a narrower span. Whether the eye-voice span is a cause or an effect will need to be determined by a careful analysis of the development of reading. This question will be considered in the last section of this chapter.

SILENT READING OF TEST PASSAGE

The facts brought out in the oral reading of the test passage suggested that a comparison with silent reading might be of interest. With this purpose in mind, photographs were taken of the silent reading of the same passage by a number of subjects. Plates XXXV to XXXVII show the records of these readings. Plate XXXVI gives the silent-reading record of Subject H7, a good reader from the sophomore class. This subject made a great many fixations per line all through the selection, which was due to the direction to "read it carefully in order to get the meaning." The larger number in the first line shows the reaction of the eye to new material. Eye-movements for the first line of any selection are seldom characteristic of the movements for the selection as a whole. The reading of the next three lines shows that the eye had settled down to a rhythmic movement. Apparently the word "bow" in line 4 caused no difficulty.

In line 5 the word "tears" caused a break in this rhythmic movement but the correct meaning was evidently obtained without great difficulty. In the next line the word "tears" caused considerable disturbance, and several regressive movements were necessary. The word "read" in line 8 caused little trouble. In line 9 the word "minute" apparently created a great deal of difficulty. The eye behaved in the same manner in this as it did in the oral selections at a point where the voice had difficulty.

PLATE XXXV



2 3 4 1 5 6 8 7 9 10
The boys' arrows were nearly gone so they sat

2 1 3 4 5 6
down on the grass and stopped hunting. Over

1 2 3 4 5 6
at the edge of the woods they saw Henry

1 2 5 4 3 6 7
making a bow to a little girl who was coming

3 2 1 4 5 7 6 8 10 9
down the road. She had tears in her dress

1 2 4 3 12 11 5 10 7 8 6 9
and also tears in her eyes. She gave Henry a

2 1 3 4 5 6
note which he brought over to the group of

2 1 3 7 6 4 8 5 10 9 11
young hunters. Read to the boys it caused

2 1 3 4 5 6 7
great excitement. After a minute but rapid

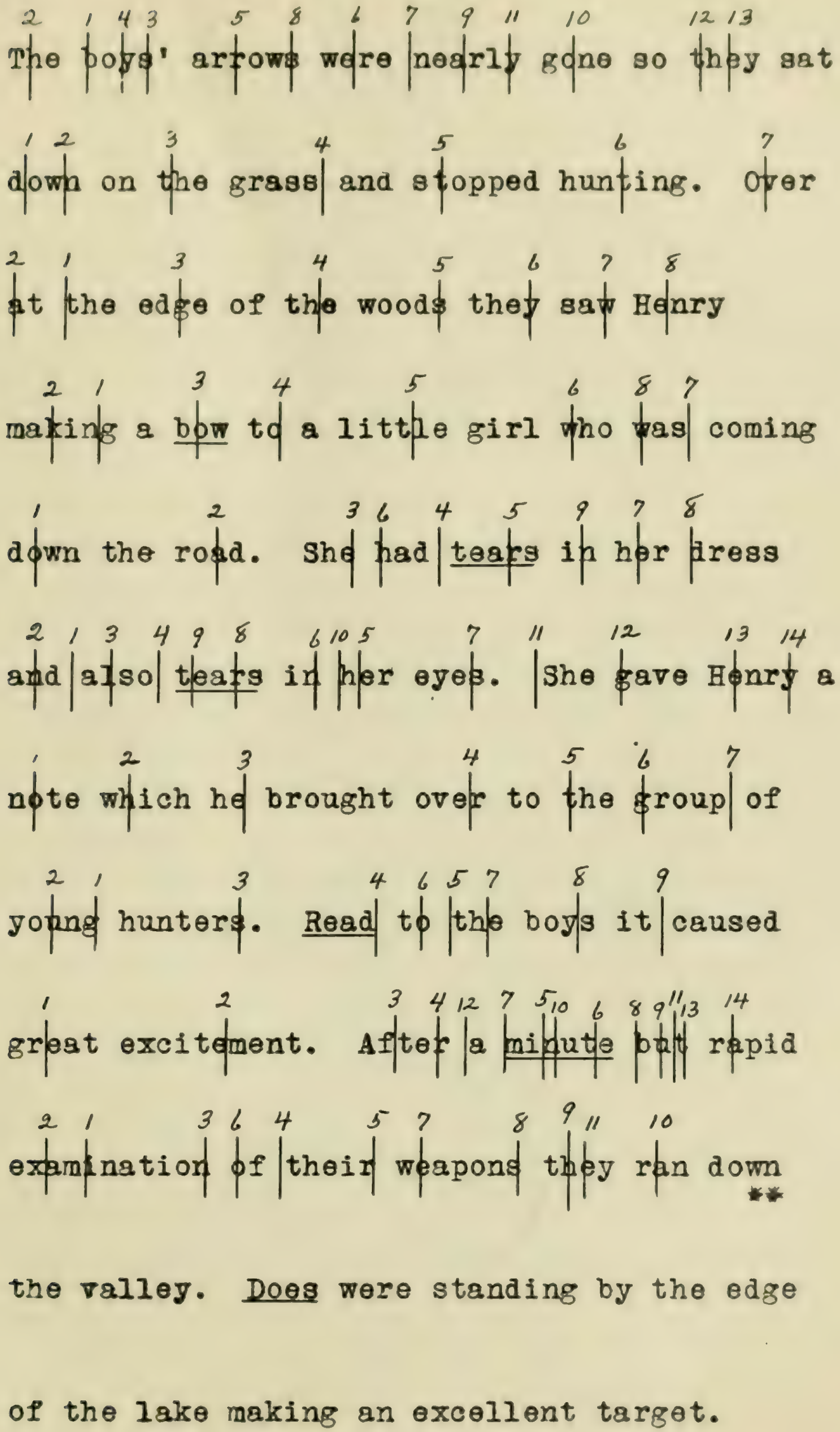
2 1 3 4 5 7 6 8
examination of their weapons they ran down

2 1 3 7 4 10 8 6 9 5 12 11
the valley. Does were standing by the edge

1 3 2 4 5 6 7 8
of the lake making an excellent target.

Silent reading of test passage by Subject H3

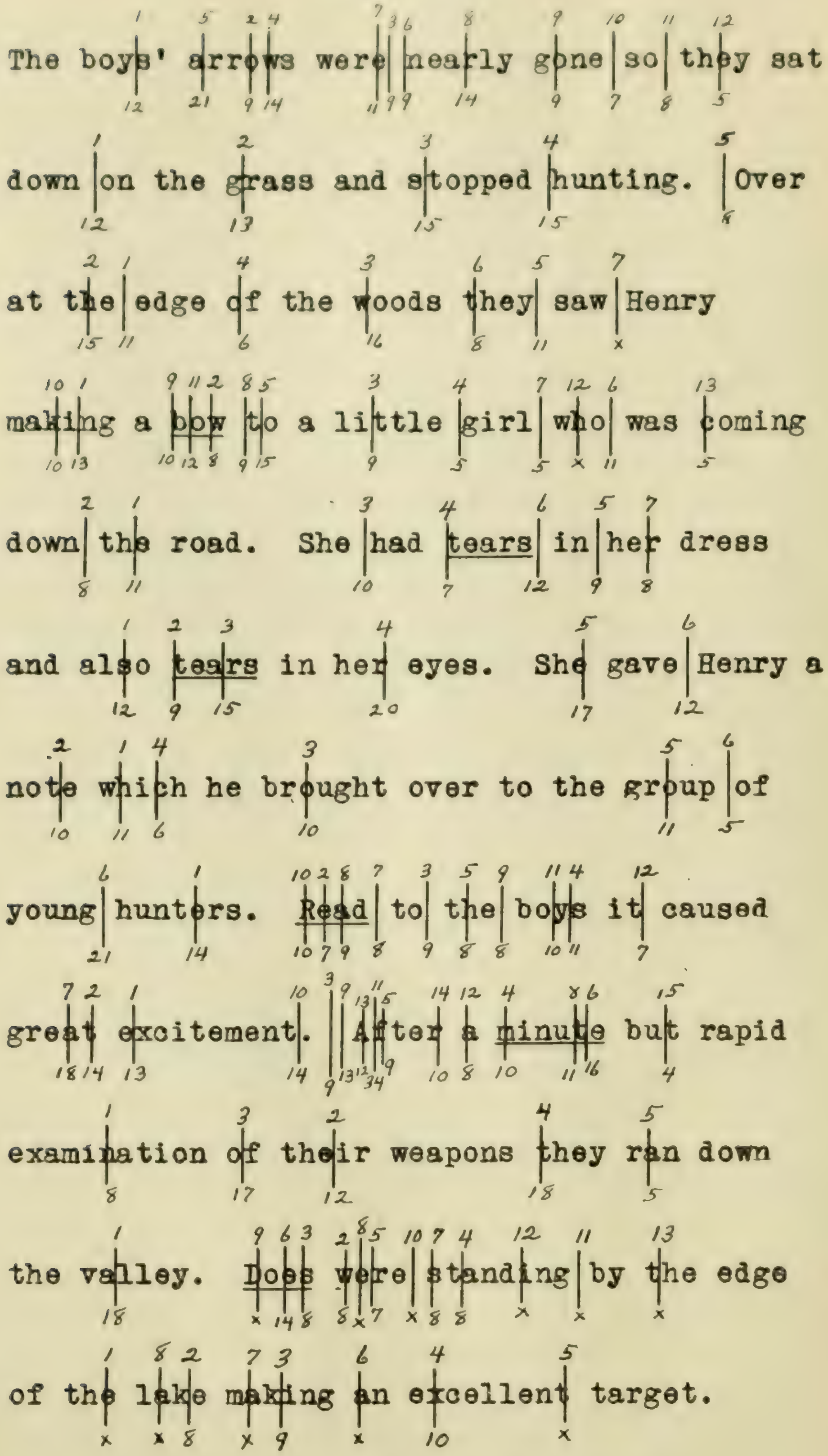
PLATE XXXVI



The boys' arrows were nearly gone so they sat
down on the grass and stopped hunting. Over
at the edge of the woods they saw Henry
making a bow to a little girl who was coming
down the road. She had tears in her dress
and also tears in her eyes. She gave Henry a
note which he brought over to the group of
young hunters. Read to the boys it caused
great excitement. After a minute but rapid
examination of their weapons they ran down
the valley. Does were standing by the edge
of the lake making an excellent target.

Silent reading of test passage by Subject H7. (**—end of film)

PLATE XXXVII



The boys' arrows were nearly gone so they sat
down on the grass and stopped hunting. Over
at the edge of the woods they saw Henry
making a bow to a little girl who was coming
down the road. She had tears in her dress
and also tears in her eyes. She gave Henry a
note which he brought over to the group of
young hunters. Read to the boys it caused
great excitement. After a minute but rapid
examination of their weapons they ran down
the valley. Does were standing by the edge
of the lake making an excellent target.

Silent reading of test passage by Subject A4

The record of Subject A4, a good reader from the college, is given in Plate XXXVII. This subject also shows a characteristic reaction to the first line of the selection, not falling into a rhythmic movement until the beginning of the second line.

The record of line 4 shows clearly that the word "bow" presents a difficulty. Evidently the wrong meaning was used at first and the eye returned to it several times before getting the correct interpretation. The word "tears" did not cause any marked disturbance in the reading. "Read" in line 8 and "minute" in line 9 each caused a radical change in eye-movement. The same kind of confusion occurs with these two words which, in the oral readings, accompanied a serious error in the reading. In line 11 the word "does" causes fully as much trouble as in any of the oral selections. This shows that the eye-movements in both oral and silent reading are largely controlled by the recognition of meaning.

THE RELATIONSHIP BETWEEN ORAL AND SILENT READING

The preceding sections have shown that the difficulties in both oral and silent reading are indicated by similar disturbances in eye-movements. The eye-movements are evidently more directly related to recognition of meanings than are the eye-voice spans. The reasons for this can be brought out more clearly if we review the development of reading from its early oral stages to the later and more mature stages of silent reading.

In a primitive or very immature type of reading the eye and voice proceed exactly together. The recognition of meaning also accompanies them. Progress at this stage is made a word at a time, or, if the word is too complex, progress is by shorter units, even letters. The attention span is so small that the eye does not move on until the voice has pronounced the word or syllable. In the case of words which are new to sight, but whose meaning is known when heard, the meaning is arrived at only by the sounding and pronouncing of the word. The oral pronunciation is a definite step in the recognition of meaning. A concrete example of such an eye-voice-meaning relationship is found in Plate VI, line 1. Here the reader is keeping his eye fixated upon the word while he is pronouncing it and getting its meaning. This pupil, who is a poor reader from the second grade, has a primitive, immature type of reading habit. Line 1 of Figure 13 represents graphically such a situation. The eye, *E*, the voice, *V*, and the meaning, *M*, keep very close together.

Plate VIII shows the record of Subject E7, a poor reader from the third grade, who keeps his eye an average of 8 letter-spaces ahead of his voice. This reader exhibits a little more complex type of reading habit. The attention span has developed until the meaning can be followed even though the eye is some distance ahead of the voice. In Figure 13 this pupil is represented by line 2. The eye is shown to be 8 letter-spaces ahead of the voice. Since this reader is still very immature and has a narrow eye-voice span it seems probable that he still relies on his oral pronunciation to get the meaning of his words, and for this reason the meaning, *M*, is located a little nearer the voice than the eye. As the student learns to read to himself the meaning attaches itself more closely to the position of the eye. Accordingly, in the other lines of Figure 13, *M* is located nearer the eye than the voice. The whole matter of the location of *M* in the figure is merely schematic since there is no objective evidence upon which an exact location can be based.

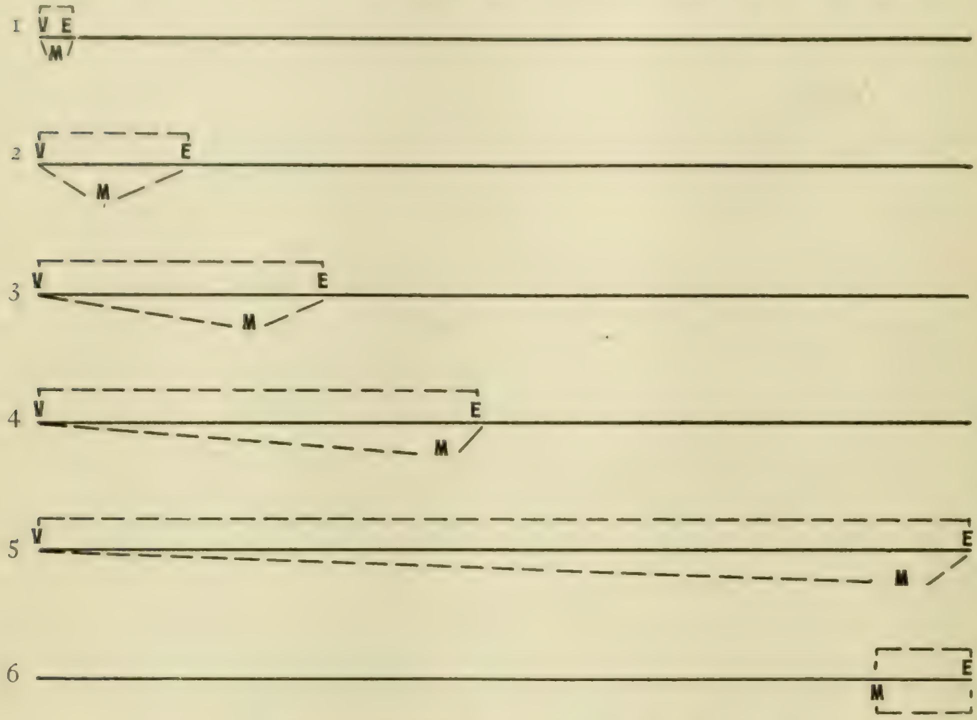


FIG. 13.—The development of the attention span in reading

The attempt to locate the position of *M* presents a very complex problem. Meaning itself is not a unitary and complete sort of thing which occurs instantaneously at certain points through the reading. After a reader has mastered his vocabulary, the recognition of the meanings of words, except in the case of new or difficult ones, doubtless occurs as soon as the eye perceives the words. The recognition of the meaning of words therefore might be said to keep pace with the eye. But the complete meaning of a sentence or a paragraph is not made up by summing together the individual meanings of the words. The meaning of each word in a sentence is modified by what precedes and follows. Phrases, clauses, or whole sentences are the units and the recognition of the complete meaning must be in a liquid state during the reading process, being subject to continual change and being held in the mind in a tentative fashion until the end of the unit of thought is reached. To speak of a location for the recognition of such a developing meaning as this would probably refer to the focal point in the moving conscious state or attention span by which the mind "carries on" in the reading process. That this focal point or the apex of the moving attention span would be nearer the eye than the voice is also indicated by the amount of conscious attention given to these two factors. The motor reaction of the voice ultimately becomes quite automatic. It follows along behind the eye at a distance such that the immediate memory association with the material perceived is kept intact but it is back in the margin of consciousness as long as no special difficulty is encountered. The principal part of the attention span is concerned with the new material which the eye is receiving, and with translating this into the meaning whole. Consequently the focus of attention is centered around the eye and the meaning, while the voice is largely left to pronounce the words automatically with a minimum amount of consciousness accompanying it.

The successive lines in Figure 13 represent increasing degrees of maturity of reading. Line 3 shows the record from Plate XXII of Subject H5, whose average eye-voice span is 12 letter-spaces. Line 4 shows the record from Plate XIV of Subject E22, whose average eye-voice span is 19.7 letter-spaces. Line 5 shows the eye-voice span of Subject H1 at a fixation in the next to the last line in Plate XXI*a*. At this point the reader's eye was 46 letter-spaces ahead of her voice, which indicates a high degree of maturity of reading habits.

The previous chapters of this study have pointed out that there is a close relationship between a good quality of reading and a wide eye-voice span. The question was raised as to which of the two is cause or effect. It would appear that both are effects, and that the causal element is the existence of a general attention span wide enough to hold a large number of words or reading elements in the mind at one time.

The preceding evidence shows that a poor, immature reader can hold only a few letters or words in the focus of attention, while more mature readers are the ones who have a wide attention span. Progress in reading would therefore be a matter of the development of the span of attention to such a degree that it would be possible for the eye to keep a considerable distance ahead of the voice and thus provide a wide margin for the interpretation of meaning. The extent to which such a span may be developed, or to which it is dependent on factors of native capacity, will need to be determined by further experimentation. The problem would seem to be worth a careful investigation through an elaborate training experiment.

It is an interesting fact to note that Subject H1, who at one point had a maximum span of 46 letter-spaces, reduced her span to 5 letter-spaces when the word "hallucination" was encountered. The same tendency to cut down the width of the span is evident whenever any difficulty is encountered. At such times the reader is placed in the same situation as a child, and returns at once to the same primitive type of eye-voice relationship which is characteristic of the habits of the immature reader.

The relation of oral to silent reading can now be shown more clearly. In such a case as that represented in Figure 13, line 1, the attention span for oral or silent reading would be the same, since the eye, voice, and recognition of meaning move along as a unit. As more mature reading habits are formed the nature of the attention span becomes different for the two processes. For oral reading it includes the eye and meaning and also in a lesser degree the voice which, because of the automatic character of its reaction, allows its conscious control to be much reduced in intensity. The silent-reading process is entirely relieved of any attention to the voice and the whole of consciousness can be focused upon the eye and the meaning. Such a situation is represented in Figure 13 by line 6. It cannot be assumed, however, that in silent reading the width of the attention span is limited to the space from the eye to the meaning. The general range of attention must cover the reading material by complete thought units, and in the silent-reading process the width of the attention span must be great enough to do this. When the reader cannot maintain a span sufficiently wide for this, he falls back into more primitive habits and pronounces the words to make the meaning clear.

It has been pointed out that when difficulties are encountered in oral reading the eye-voice span is immediately reduced to a primitive form. The same thing occurs in silent reading. When the difficult words in the test paragraph were encountered in silent reading, the eye returned to the word causing the difficulty, just as it returned to the position of the voice in oral reading. An example of such a case is shown in Plate XXXIII at the word "read" in line 8. Here the reader experienced a difficulty in interpretation of the meaning at that point, and the eye which has passed the word "boys," returned to the word "read," cutting down the span from the eye to the recognition of meaning to zero in the same manner as in oral reading. If the difficulty in getting the meaning in silent reading is sufficiently great, there is a reversion not only to the habit of bringing the eye back to the location of the recognition of meaning, but also to the most primitive habit of silently pronouncing the words. This reinstates the most primitive form of reading where the eye, the voice, and the meaning proceed together.

The development of the reading process may therefore be traced through three stages. First, the most primitive or immature stage of oral reading where the eye, the voice, and the meaning are all focused at the same point. Secondly, the more mature stage of oral reading where there is a considerable span between the eye and the voice, with the recognition of meaning occurring at a point nearer to the position of the eye. Thirdly, the stage of silent reading where the reader is entirely relieved of any attention to the voice and where the entire attention can be given to the eye and the meaning, making possible the development of a much higher degree of proficiency.

In chapter ii it was observed that some good readers in the fifth grade had an average eye-voice span greater than many high-school pupils. The fact that some pupils had developed such a wide span during the first four years of school would indicate a possibility that, with sufficient emphasis and appropriate method, a wider span could be developed with other pupils. The time for the teaching of oral reading is during the first four school years. By the time the fifth grade is reached the mechanics of reading should be mastered by the pupils and a larger amount of silent reading given. Figure 3 makes it clear that a great many pupils have not succeeded in developing a wide eye-voice span even at the high-school level. If the assumption is true, as the evidence indicates, that a wide eye-voice span is closely related to a wide attention span, and that a wide attention span is essential to good silent reading, it is highly important that a wider eye-voice span should be developed if possible during the first four years of school. It should be developed during these years, first, because that is the period during which oral reading predominates, and secondly, because the advantage of a wide attention span should be made available for silent reading by the beginning of the fifth grade.

The fact that the subjects from the freshman class of the high school showed a wider eye-voice span than the subjects from the sophomore and junior years was ascribed to the special training given to this class by the English department. Evidently there were some elements of method in the special training which affected the eye-voice span. These specific methods should be available for use in the first four school grades. The results of this investigation indicate that the development of the eye-voice span is a factor of sufficient significance, for both oral and silent reading, to warrant further research through a training experiment making use of specific methods having this end in view.

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